# Natural History and Restoration of Peregrine Falcons in California

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# NATURAL HISTORY OF PEREGRINE FALCONS IN CALIFORNIA

## Introduction

This report concerns the American peregrine falcon (*Falco peregrinus anatum*) in California, with emphasis on the portion of the population which occupies nesting territories on the Channel Islands of coastal southern California.

The peregrine is an aerial predator that captures its prey in the air. Peregrines employ many hunting techniques. The most famous is when a single falcon soars to one- to two-thousand feet in the sky, and then dives at speeds exceeding 150 miles per hour, striking or grabbing its prey hundreds of feet below the start of the dive. Tandem flights also occur wherein two peregrines alternately dive on selected prey individuals.

Peregrines are primary predators at the top of their food-web, and rarely suffer predation themselves. Man is an occasional mortality factor in the modern world. Great horned owls (*Bubo virginianus*) and golden eagles (*Aquila chrysaetos*) occasionally kill fledgling peregrines, and, less often, adults. Newly fledged peregrines may rarely be killed by ground predators such as coyotes (*Canis latrans*).

The peregrine is one of only five avian species with a cosmopolitan distribution. Peregrines breed on islands and coastlines throughout the world, and in mild interior locations. Only deserts remote from rivers, lakes, or reservoirs or the most harsh icy climates are not used for breeding. Before sexual maturity or during the non-breeding season, peregrines may be found in any habitat at almost any elevation and latitude. This tendency earned them the name peregrine, or "wanderer".

Predators are vital to natural systems' complexity and health. They are one of several important pressures on fauna as a natural selection mechanism, helping to enhance survival of the fittest organisms or genes to allow evolution into future generations.

Peregrine falcons are important to people for many reasons. They are beautiful. They are often misidentified, but revered, as the fastest-flying bird. They are prized for falconry. They are relatively rare, and watching them hunt is exciting. On another level, millions of people negatively impacted peregrines, but a small group of people worked to protect and restore them for their biological value. This biological value qualified them to be on the first lists for both the Federal and State Endangered Species Acts.

Peregrines are endangered species because of the loss of productivity caused by DDT. The peregrine has many qualities that enable the human effort at its recovery to succeed. Some believe that the peregrine has adapted to humans. In reality, it is actually a creature of the air. The peregrine cares as little about mankind as it does bison, caribou, or cattle, provided that its immediate nest ledges, perches, etc., are not disturbed.

## General Description

The peregrine is one of five falcon species that occur in California. The others are the merlin (*Falco columbarius*), the American kestrel (*Falco sparverius*), the prairie falcon (*Falco mexicanus*), and the gyrfalcon (*Falco rusticolus*). Merlins and kestrels eat small birds and insects, and occur on the Channel Islands as migrants or in the case of kestrels, breeders. Prairie falcons and gyrfalcons do not occur on the Channel Islands except possibly as very rare migrants.

Three subspecies of peregrine occur in North America, and all are seen in California and on the Channel Islands. *F. p. anatum*, or the American peregrine falcon, is the only subspecies that is resident and breeds in California. The American peregrine falcon population is a large, widely dispersed, interacting group extending from temperate Alaska through Canada to the East Coast, south into the southern Appalachians and the Rocky Mountain region, and on into Mexico, the Big Bend region of Texas, and Baja California and the Gulf of California Islands.

In order for a subspecies to be genetically maintained over such a wide area, there must be overlapping dispersal of individuals throughout the range. Thus, there are territories in many areas, but there are no isolated "populations" of *F. p. anatum* such as the "Baja population", the "California population", or the "Channel Islands population". Although humans often see mountain chains, urban sprawl, deserts, or ocean areas as barriers, peregrines can travel in level flight over 50 miles an hour and cover great distances within minutes, let alone days or lifetimes.

In the Arctic, there is a highly migratory subspecies known as the tundra peregrine (*F. p. tundrius*) which, in order to escape the harsh arctic winter, "leapfrogs" the more-resident American peregrine falcons across continental North America and flies south into South America to "winter" in the South American summer. Some of these birds pass through California on their journey, mostly in late September and early October, and then wander back through on their return migration, largely in April. This subspecies is smaller, longer-winged, and generally lighter in plumage than the American peregrine falcon. Tundras occasionally occur on the Channel Islands as migrants. Plumage alone is not adequate to determine subspecies, and American and tundra peregrine falcons can appear very similar in plumage. Some faded American peregrine falcon immatures and some lighter adult American peregrine falcons are indistinguishable from tundra peregrines.

The third subspecies, from the Pacific Northwest including coastal regions of the Aleutian Islands, Alaska, British Columbia, and Washington, is the largely resident *F. p. pealei*, or Peale's peregrine falcon. This large group of peregrines nests mostly on islands. Some are migratory, and Peale's peregrines visit California every year in undetermined but small numbers. They are seen on all islands, at many coastal estuaries, and occasionally in slightly interior locations as wintering birds from October through April. They have been documented on the Channel Islands and as far south as San Diego.

All peregrines capable of flight are fully grown. One-day-old young weigh approximately 50 grams, and reach full adult size and flight capabilities in eight weeks. Peregrines essentially have two plumages; immature and adult. There is almost no sexual dimorphism in plumage. Sexes appear essentially identical except for size.

Like most birds of prey, peregrines exhibit the reverse of the usual sexual size-dimorphism seen in many animals. Female peregrines are larger than males, appearing one-third to one-half larger. Females can weigh 32-40 ounces, while males are generally in the 20-24 ounce range. There are exceptions to these generalizations, but there is no overlap in size and weight between male and female peregrines originating in California. Tundra peregrines are smaller or the same size as American peregrine falcons. Peale's peregrines are almost always larger than American peregrine falcons.

Immature peregrines, upon fledging, are full-sized and most of their morphological measurements are comparable to adults. However, immature flight feathers are slightly broader and longer. Fledglings weigh less than adults because of their relative lack of physical conditioning.

## History

Peregrines were relatively common throughout California when first described by scientists in the early 1900s, and were a part of Native American history and culture. There were no statewide surveys conducted before 1970 – only information from individuals on nests in local areas. This information was obtained mostly from field notes or personal conversations between Santa Cruz Predatory Bird Research Group (SCPBRG) personnel and falconers, egg collectors, naturalists, California Department of Fish and Game wardens and biologists, and other agency or university biologists. The historic breeding population size was never determined, but estimates based on compilation of these local reports indicate there were routinely over 100 nest territories occupied yearly in California. Possibly as many as 300 territories may have been occupied when the peregrine was at carrying capacity in the environment prior to the great impact caused by modern humans. Evidence suggests the peregrine was at carrying capacity on the Channel Islands through the 1940s. In a review of available information, Kiff (1980) presents evidence for 14-16 recorded pairs on the California Channel Islands during the first half of this century, and suggests a resident population of at least 20 pairs. In most areas of peregrine range, the estimates of historic population have been considerably smaller than the actual recovered population size, suggesting that historic records underestimated the true population.

In the 1950s, nest territories on the Channel Islands became abandoned, and various observers described territory abandonment in other parts of California. Visible causes of fatality included shooting, harvest for falconry, predation on eggs by ravens, and egg collecting. None of these factors were unique to peregrines. No explanation was available as to why peregrine numbers were declining while other species in the area were not. Egg collectors noted declines in local populations. Although no population impact on any species is known to have been caused by egg collecting, the practice became strictly regulated during this period.

Peregrine falcons became rare in the 1960s. Falconers documented territory abandonment, and eventually harvest for falconry was made illegal. General acceptance of predator control diminished. The peregrine received legal protection from shooting. Almost all peregrine territories were determined to be abandoned by local observers during this time – reduction likely exceeded 90%.

By the early 1970s, the American peregrine falcon was nearly extirpated in California. In the first statewide survey, conducted by Steve Herman for the California Department of Fish and Game, only two territories were found to be active in an analysis of most known and suspected nest territories. Herman estimated that the reduction in the breeding population exceeded 95%

(Herman 1970). During this period DDT was identified as the cause of eggshell thinning in peregrines and other fish and meat-eating birds (Hickey 1988). The chemical's use was restricted because of increasing immunity of insect pest populations, the cancer threat to humans storing DDT in fat, and thin eggshell-caused declines in birds. Affected species included peregrines, brown pelicans (*Pelecanus occidentallis*), and bald eagles (*Haliaeetus leucocephalus*). All three species experienced severe reproductive failure in California in the 1960s.

Also in the early 1970s, both the State and Federal Endangered Species Acts were enacted and the peregrine was included on the original lists for both laws. A Federal Recovery Team and a State Working Team were formed, and a Recovery Plan (1982) was drawn up to delineate steps to prevent extinction of the subspecies. A Federal Endangered Species Permit and a State of California Memorandum of Understanding were provided to SCPBRG to begin wildlife management and captive breeding work with peregrine falcons.

In the 1980s, large-scale releases of peregrines occurred in many areas of the former range. Shooting, falconry harvest, egg collecting, and other human-induced mortality factors had been reduced. DDT application in nest territories and wintering areas for California peregrines had been curtailed. Protection was afforded to the immediate area of peregrine nesting cliffs. Peregrines began using urban prey populations to a greater extent. Nest territories in the vicinity of releases began to be reoccupied. Essentially, a recovery began and extinction was avoided in California.

Pesticide-induced nesting failure continued in many areas, including the north-coast ranges and the Sierra Nevada, but vacant nesting territories continued to become reoccupied by breeding adults. The most severe continuing nesting failure was along the coast. In the Big Sur area immediately north of the Channel Islands region, nests routinely failed and eggs with 25-35% eggshell thinning continued to be laid and broken. This group of falcons was largely composed of released birds. Despite reproductive failure, the rate of recovery of occupied territories was increased in this area through releases. During this period peregrines returned to the Channel Islands as a nesting species for the first time since the 1950s. Because of releases of captive-hatched young, the return of the peregrine proceeded despite continuing diminished reproductive success.

During the 1980s, DDT was not directly applied to peregrines' environs for the first time since the 1940s. However, as falcons aged, residual DDT/DDE became stored in fat reserves. DDT/DDE was recirculating in the air and water, and prey species stored DDE that they picked up from agricultural, coastal, marsh, esturarine, and other sediments. In areas far from historic and current sources of DDT, some improvement occurred. No territory was found to be free from pesticide impact. Eggshell thinning continued to occur at undesirable levels for peregrines in California as a whole. Peregrines picked up pesticides throughout their lives. The worst eggshell thinning was associated with areas of direct application or immediate local sources of DDE. Some territories farther from applications or direct sources had better reproduction.

In the 1990s, larger-scale recovery of the peregrine falcon in California is occurring. Most recovery goals for recovery regions delineated in the Recovery Plan are being realized. Productivity has improved in virtually all areas but remains depressed from normal historic levels, especially in Big Sur and the Channel Island regions. Urban populations have increased to roughly 10% of the known breeding population. More intensive surveys of non-urban habitats are needed to accurately determine the breeding population size. The statewide population certainly

exceeds 135 nesting pairs. The U. S. Fish and Wildlife Service is considering delisting the subspecies throughout its range. SCPBRG continues releases in areas that have lower productivity, and releases may be required to increase the rate of recovery in areas where the population has not completely recovered (the Channel Islands and the North Coast). Current DDT impact appears to be a mortality factor that reduces productivity in some nests, but not the population-decimating mechanism of the 1960s and 1970s. Telemetry and identification of banded birds is providing information on the success of the release program, movements of peregrines, mortality factors, and recovery in general. Because of the comparatively large number of territories occupied in the 1990s, overall statewide surveys and monitoring are more difficult and financially problematic than in the 1980s. SCPBRG continues to maintain databases and collect behavioral and population information. Eggshell thinning levels for territories in California as a whole are slightly improved and in some areas do not exceed the 17% thinning level associated with population failure.

## Life History

Generally speaking, peregrines are monogamous, mate for life, and breed in the same territory their entire life. Exceptions exist. On rare occasions during the recovery period of the 1980s and 1990s, one male has been documented breeding with two females in adjacent territories. When one mate dies during any time of the year, a replacement is recruited, often immediately, by the surviving individual. In historic times when the population was at carrying capacity and all territories were occupied, this was the only method for a peregrine to become a breeder. In the recovering population, nests in long-abandoned territories are often established when one bird of either sex recruits a mate and first breeding occurs. There are also examples where a peregrine moves and mates with a different falcon, abandoning a mate or being forced out by a new falcon. Thus, there are also records of peregrines moving between territories in subsequent years. While there are examples of these exceptions by both sexes in each category, the initial statement is correct for peregrines in the majority of cases.

First-year peregrines wander great distances from their nest area after dispersal. Originally, first-year mortality in raptors was suggested to exceed 70%. During the recovery period in California, mortality of peregrines appears to have been much lower than that, but it is not exactly known. Lower mortality was suggested by a greater number of banded released falcons showing up as adult breeders than would have been expected were first-year mortality as high as predicted.

Physiological sexual maturity usually occurs during the second year, but some peregrines do not breed until several years later. Age at first breeding and length of breeding life have not been accurately determined, but both have a wide range. Peregrines have bred at age one, and some current breeders in California have already bred for 16 years.

The mortality rate of adults is not clearly known. Many peregrines disappear between breeding seasons and the cause usually cannot be determined. There are known mortality factors such as wire strikes, botulism, shooting, window strikes, car impacts, and a variety of others. None are considered at this time to be significant overall impacts on the population.

Dispersal distance from the nest where peregrines hatch to where they breed based on band recoveries indicate that they almost never breed at the nest from which they fledge. Males and females both usually disperse from the natal area, although on average females move farther. As a result of this dispersal, there is movement (recruitment) of birds from north to south, high to low

elevation, mainland to island, urban to wilderness, and the reverse occurring throughout California and the West. As with most bird populations studied, there are many short- to medium-distance dispersing birds and also a few long-distance dispersals.

Since peregrines wander great distances prior to attaining a territory, and mates are recruited randomly and throughout the year because of unpredictable fatality of the members of nesting pairs, it is possible for falcons originating in extreme northern or southern California or high in the Sierras to nest on the Channel Islands. It is more likely that recruitment of mates on the Islands will occur from Big Sur, other islands, coastal foothills, or urban southern California nest sites, as can be seen from existing band recoveries (Figures 10-19).

A crucial, as yet difficult-to-quantify fraction of the peregrine population are called "floaters". These are sexually mature falcons seeking nesting territories, or "serviceable breeding locations", where disappearance of one member of the pair has occurred. Virtually all nests, even during the low point in the population size, are visited during the breeding season by floaters testing the territory for availability of a breeding opportunity. The number of these floaters may equal or even exceed the number of breeders but their population size cannot accurately be determined at this time. During the DDT-induced decline and low productivity of fledglings (hence a low number of floaters), floaters may have become non-existent, since many remnant territories were occupied by immature falcons. Early in the recovery, some territorial pairs included an immature bird.

Exceptions exist to generalities about the peregrine's annual cycle. Differences often are attributed to weather or factors easily identified by human observers, but may actually more often be a result of changes in breeding adults (origin, prey preferences, age). Generally speaking, pairs remain in the area around the nest cliff enough from July to January (i.e. the non-breeding season) to maintain possession of the nest site and drive out competitors such as ravens, eagles, and "floating" peregrines. The reproductive organs become small and quiescent during the non-breeding season, which reduces weight, conserves energy, and enhances survival. Beginning 21 December, which is the winter solstice, day length begins to increase and stimulates hormonal changes leading to gonadal development. Females gain weight in preparation for egg production. Males begin provisioning females more frequently, which begins courtship. Gonadal development is usually sufficient by early February for copulation to begin. In some cases the male provides all food to the female during this period, and in other cases the female continues to hunt for herself.

Peregrines almost always lay three or four eggs. Eggs are laid approximately at 48-hour intervals, so the complete clutch takes eight or nine days to lay. Incubation often begins with the second or third egg.

After approximately a month of copulation, eggs are laid in March or April. Eggs have been recorded in February through September because of individual variation, loss of first clutches, age of female, inclement weather, elevation, or possibly other factors, but the majority of eggs on the Channel Islands are laid in March.

Incubation takes approximately 33 days. Both sexes incubate, with the female performing the larger share. Usually, two or three young hatch closely together and one follows in a day or so. Pesticide exposure causes variation in eggshell quality and contents, which can induce breakage, embryo mortality, or other problems. If the entire clutch breaks, particularly in clutches laid early in the breeding season or eggs broken early in incubation, a second, replacement clutch is laid. Historically, eggs were sometimes lost to predation, substrate problems, weather, or accidents, but

falcons that laid replacement clutches were genetically favored. This ability to lay a second clutch was used to great advantage by managers to increase productivity and aid the population during the hands-on management phase of the recovery program.

Young are in the nest for approximately 42 days. Both sexes usually feed the young, although during the first two weeks the male usually gives food to the female, who then feeds the chicks. The young are helpless and cannot thermoregulate for the first 14 days, and therefore must be brooded. After 18 to 21 days depending on the nest ledge, they can be left alone. Adult females can begin to hunt again, assisting the adult male, who to this point in the cycle has provided virtually all of the food for himself, the female, and the young. The female, being larger than the male, is able to bring larger prey to the nest.

Males usually fledge earlier than most females, 38-40 days and 40-42 days old, respectively. Depending on visibility of the nest ledge and order of hatch, it can be difficult to age nestlings or accurately determine the fledging date or age. The fledglings seldom return to the nest ledge. They wander locally and are brought food by both adults. It is difficult to determine fledging success soon after fledging, so productivity is usually described as the number of large young seen on the nest ledge prior to fledging. Adults continue to feed the fledged young until they become capable of hunting. Some young soon leave the area. By six weeks after fledging, most young have dispersed from the natal territory.

Sensitive periods for disturbance at peregrine nests include the following. During copulation and courtship disturbance can result in infertile eggs, relocation to another nest ledge, and possibly abandonment of a nesting attempt. During egg-laying and incubation, disturbance can result in egg breakage (particularly at sites with pesticide problems), premature laying of eggs lacking a proper shell, or eggs being laid on more than one ledge. Near fledging, disturbance can cause young to prematurely leave the nest prior to developing adequate flight feathers and the ability to glide or fly, resulting in mortality.

Disturbance caused by human activity too close to the nest during a breeding season has in several cases been linked to movement of a breeding pair in subsequent breeding seasons, but rarely has disturbance caused abandonment of eggs or young. Currently, disturbing a peregrine nest to the point of stimulating the territorial "cack-cack-cack" vocalization is a violation of the Endangered Species Act.

## Peregrine Territories

Peregrine hunting territories, or home ranges, are often described by the terrestrial component of the environment in which they occur. In actuality, peregrines hunt in the air, perching or nesting on whatever suitable substrate is available in areas of large numbers of available prey, usually where prey species are highly varied. Although peregrine activity is essentially the same, nest territories can be in areas of forest, marsh, grassland, sandy beach, open ocean, and urban or partially developed human-impacted terrain. Prey availability is partially a result of surface conditions, so in each area different species become available. When pursued, land birds cannot escape into the ocean, seabirds cannot escape into terrestrial habitats, and few birds find suitable escape cover in urbanized habitats.

In areas of very high prey concentration, territory size and home range may be small and pairs may have adjacent territories. In other areas, territory size and home range may be very large and nest sites may be widely spaced.

Peregrine perches can include the ground, trees, cliffs, and also ships, utility poles, and buildings. Eggs may be laid on the ground, in nests constructed by other species, in trees, or on structures. In California and on California islands, nests are by far most-often in ledges or potholes on cliffs. Falcons do not build stick or other types of nests.

Nests exist throughout most of California. All California islands have been occupied historically, as well as many offshore rocks. The defended area around the nest is often only several hundred yards in diameter, and nests can be a few hundred yards or a few miles apart in some areas. The home range is considerably larger, and observers usually report adults leaving nests and flying out of binocular range in all directions on foraging flights.

Peregrines are seen at their nest cliffs and in the area of their defended breeding sites year-round in California. Some territories at high elevations or northern latitudes may be seasonally used because of inclement weather, but peregrines in California do not migrate. They can be seen at nest cliffs on the Channel Islands year-round, but may move considerable distances away from the cliffs during the non-breeding season.

## Peregrine Prey

Prey remains including feathers, bones, etc., have been collected from nests in California from 1971 to 1997, representing hundreds of collections. Prey consumed by California peregrines is highly varied, but consists of over 99 percent birds and bats. At no nest site do peregrines concentrate on a single or few prey species. Peregrines are generalists which hunt the large variety of prey that occur in their home range. While they help the general ecology of a region by eating some "handicapped" old, sick, weak, vagrant, or odd individuals, the vast majority of prey taken consists of normal, healthy individuals from any prey population. Prey ranges in size from hummingbirds and small bats that can easily be consumed in the air, to large waterfowl and gulls that are knocked to the ground. Often, the latter are only partially eaten because of the amount of food to be consumed and competition with other birds and animals that quickly occurs on the ground. Large prey is taken primarily during the non-breeding season, since it cannot be delivered to the nest cliff. The list of peregrine prey species in California now includes the majority of species that occur regularly in the State that are of normal peregrine prey size. Typical prey found in most nests or taken by most individuals depending on region include mourning doves, killdeer, blackbirds, starlings, meadowlarks, rock doves (feral pigeons), phalaropes, terns and small gulls, finches, swifts, swallows, and various shorebirds.

Prey items include year-round local residents, year-round California residents, and migrant species. Prey selection within territories may change during the year because of the sex of the preying falcon (e.g., male feeding female), time of annual cycle (e.g., pair in courtship or pair feeding young), or even individual prey preferences (e.g., male eating smaller species than female or individual preferring land birds to seabirds).

Table 1 lists species confirmed as peregrine prey items in California. This list is derived primarily from identified prey remains collected from nest sites, and secondarily, from reliable observers witnessing predation events. The list includes prey species that have been recorded in winter,

during courtship, during egg laying and incubation, and while adults are feeding young. However, each species is not necessarily used at all times of the year by peregrines, nor do both sexes or all age groups of peregrines use all species. There are undoubtedly many species that are eaten by peregrines in California that are not included in this list.

**Table 1. List of Confirmed Peregrine Prey Species in California.**

(n = 175)

western grebe
red-necked grebe
horned grebe
eared grebe
pied-billed grebe
sooty shearwater
Leach's storm-petrel
fork-tailed storm-petrel
pelagic cormorant
black-crowned night-heron
green heron
cattle egret
snowy egret
mallard
gadwall
green-winged teal
American widgeon
northern pintail
northern shoveler
cinnamon teal
ruddy duck
wood duck
lesser scaup
common goldeneye
bufflehead
common merganser
clapper rail
sora
American coot
black oystercatcher
American avocet
black-necked stilt
snowy plover
semipalmated plover
American golden plover
killdeer
mountain plover
black-bellied plover
marbled godwit
long-billed curlew
whimbrel
willet
greater yellowlegs
lesser yellowlegs
solitary sandpiper
spotted sandpiper
wandering tattler
red-necked phalarope
red phalarope
short-billed dowitcher
long-billed dowitcher
common snipe
ruddy turnstone
black turnstone
surfbird
red knot
dunlin
sanderling
western sandpiper
upland sandpiper
Heermann's gull
Bonaparte's gull
ring-billed gull
mew gull
California gull
western gull
common tern
Forster's tern
least tern
black tern
elegant tern
Caspian tern
pigeon guillemot
Xantu's murrelet
marbled murrelet
Cassin's auklet
rhinoceros auklet
white-tailed kite
sharp-shinned hawk
American kestrel
blue grouse
California quail
mountain quail
band-tailed pigeon
rock dove
mourning dove
spotted dove
cockatiel
budgerigar
canary
barn owl
western screech owl
burrowing owl
common poor-will
common nighthawk
black swift
Vaux's swift
white-throated swift
hummingbird sp.
belted kingfisher
northern flicker
acorn woodpecker
white-headed woodpecker
red-breasted woodpecker
Lewis' woodpecker
downy woodpecker
hairy woodpecker
Nuttall's woodpecker
pileated woodpecker
western kingbird
ash-throated flycatcher
black phoebe
Say's phoebe
horned lark
tree swallow
violet-green swallow
purple martin
bank swallow
cliff swallow
barn swallow
western jay
Steller's jay
gray jay
Clark's nutcracker
yellow-billed magpie
American crow
common raven
plain titmouse
chickadee sp.
bushtit
brown creeper
white-breasted nuthatch
red-breasted nuthatch
house wren
Bewick's wren
canyon wren
western bluebird
mountain bluebird
Townsend's solitaire
Swainson's thrush
hermit thrush
varied thrush
American robin
northern mockingbird
American dipper (?)
cedar waxwing
European starling
yellow-rumped warbler
Townsend's warbler
Wilson's warbler
yellow warbler
black-headed grosbeak
California towhee
song sparrow
chipping sparrow
dark-eyed junco
white-crowned sparrow
golden-crowned sparrow
fox sparrow
western meadowlark
red-winged blackbird
Brewer's blackbird
brown-headed cowbird
Bullock's oriole
hooded oriole
western tanager
house sparrow
pine siskin
American goldfinch
lesser goldfinch
Lawrence's goldfinch
red crossbill
purple finch
house finch
evening grosbeak

# RESTORATION OF PEREGRINE FALCONS IN CALIFORNIA

## Introduction

Peregrine restoration in California was conducted by SCPBRG under Federal Endangered Species Permits and State Memoranda of Understanding. Recovery activities conducted by SCPBRG coincided with crucial legislation and protection efforts. The Endangered Species Act and other laws reduced mortality of peregrines. Restriction of DDT use in California generally reduced the amount of that pesticide that individual peregrines were subjected to in most areas. Peregrines' nesting habitat was protected, and their ability to occupy urban areas caused human impacts on habitat to be minimized. The peregrine's ability to breed in both historic, natural eyries and on man-made structures in urban areas meant that the species could recover to its historic population size. The combination of these and other factors enabled restoration in most areas. The terrestrial element of peregrines' habitat was altered during the past 50 years, but this resulted in very little breeding habitat loss because peregrines depend only on the availability of avian prey they catch in the sky.

Since the mid-1970s, all direct peregrine recovery actions in California and Oregon have been conducted under permits issued to SCPBRG under the direction and responsibility of Brian James Walton. This includes all nests entered, eggs and prey remains collected, young released, peregrines radio-telemetered, peregrines intentionally trapped, virtually all peregrines banded, and other activities concerning peregrines.

## Population Size

The pre-1946 breeding population in California unquestionably exceeded 100 pairs per year. Estimates suggest that 300 pairs may have been present at the turn of the century and later. The carrying capacity of the Channel Islands certainly exceeds 20 pairs. Few factors affecting peregrine prey availability, habitat availability, and nesting ecology on the Channel Islands have changed between 1946 and 1997, so the carrying capacity probably remains the same. By 1997, the number of territories on the Channel Islands remains slightly above 10 pairs annually, roughly 50% of estimated carrying capacity.

The breeding population in California dropped to two known pairs by 1970. The Channel Islands nest territories were likely all abandoned in the 1950s, with only a slight possibility of productivity at a few locations until the 1990s. Reoccupation of historic territories began in the late 1980s, when a male released by SCPBRG on San Miguel Island remained near the release site and attracted a mate.

Figure 1 depicts breeding population growth in California from 1975 through 1992 with a projected breeding population estimate to 1997. Since the State is large, and the peregrine falcon population is very widespread, statewide surveys have not been conducted since 1992. The next statewide survey is scheduled for 1998. The projected growth through 1997 is based on the prior growth rate and the fact that in areas surveyed since 1992, the number of breeding territories increased. Figure 2 shows the general location of current or recent territories in the State by region, and Figure 3 depicts the population recovery by five-year increments. Figures 4 and 5 are reoccupation maps for the Central Coast Region including the Channel Islands, and Channel Island nest sites.

Figure 1. Census Results of California Peregrines Through 1992 and Estimated Population Size Supported by Increased Number of Territories in Sampled Regions Through 1997.

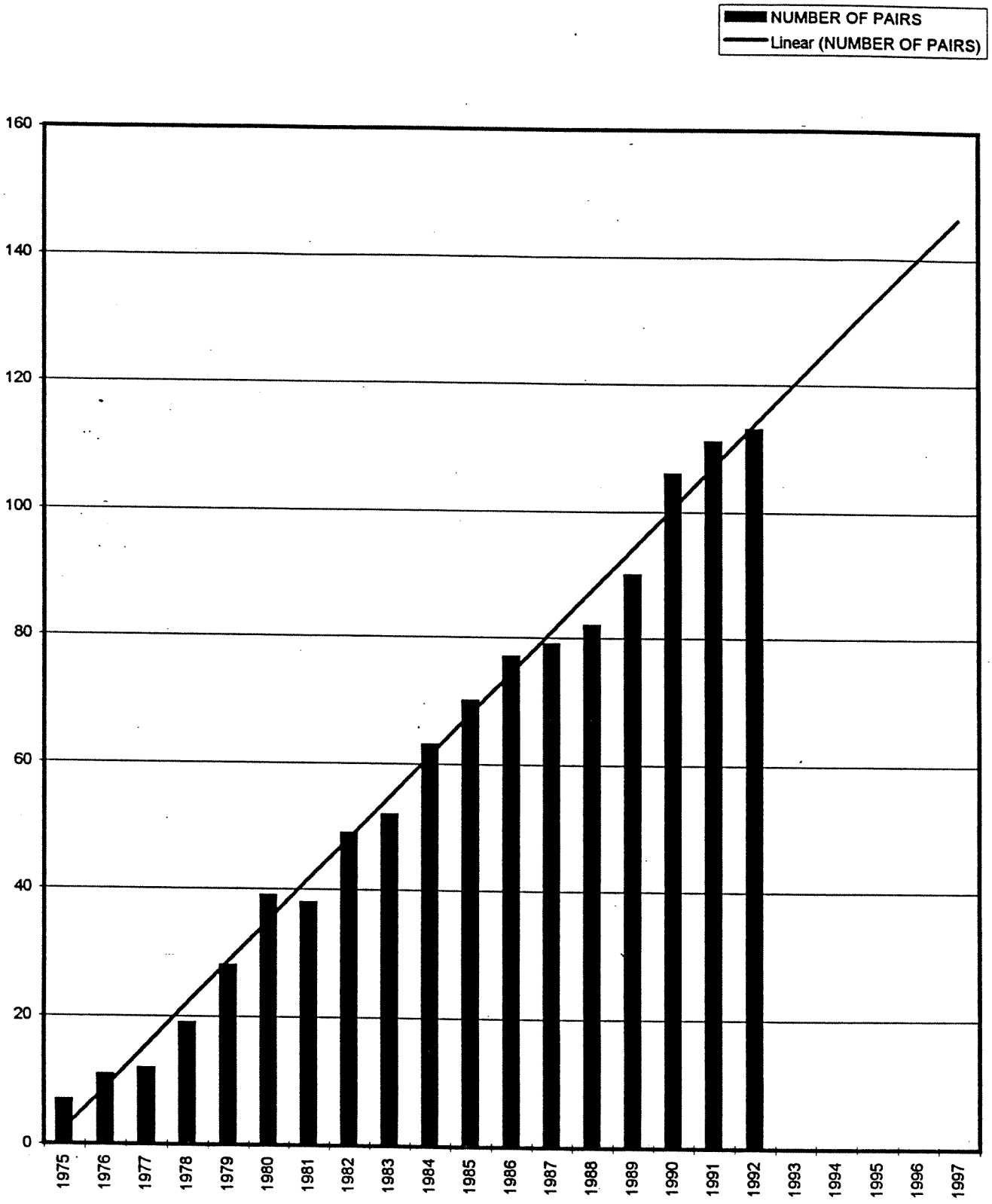


Figure 2. Locations of Current and Recent California Eyries by Region.

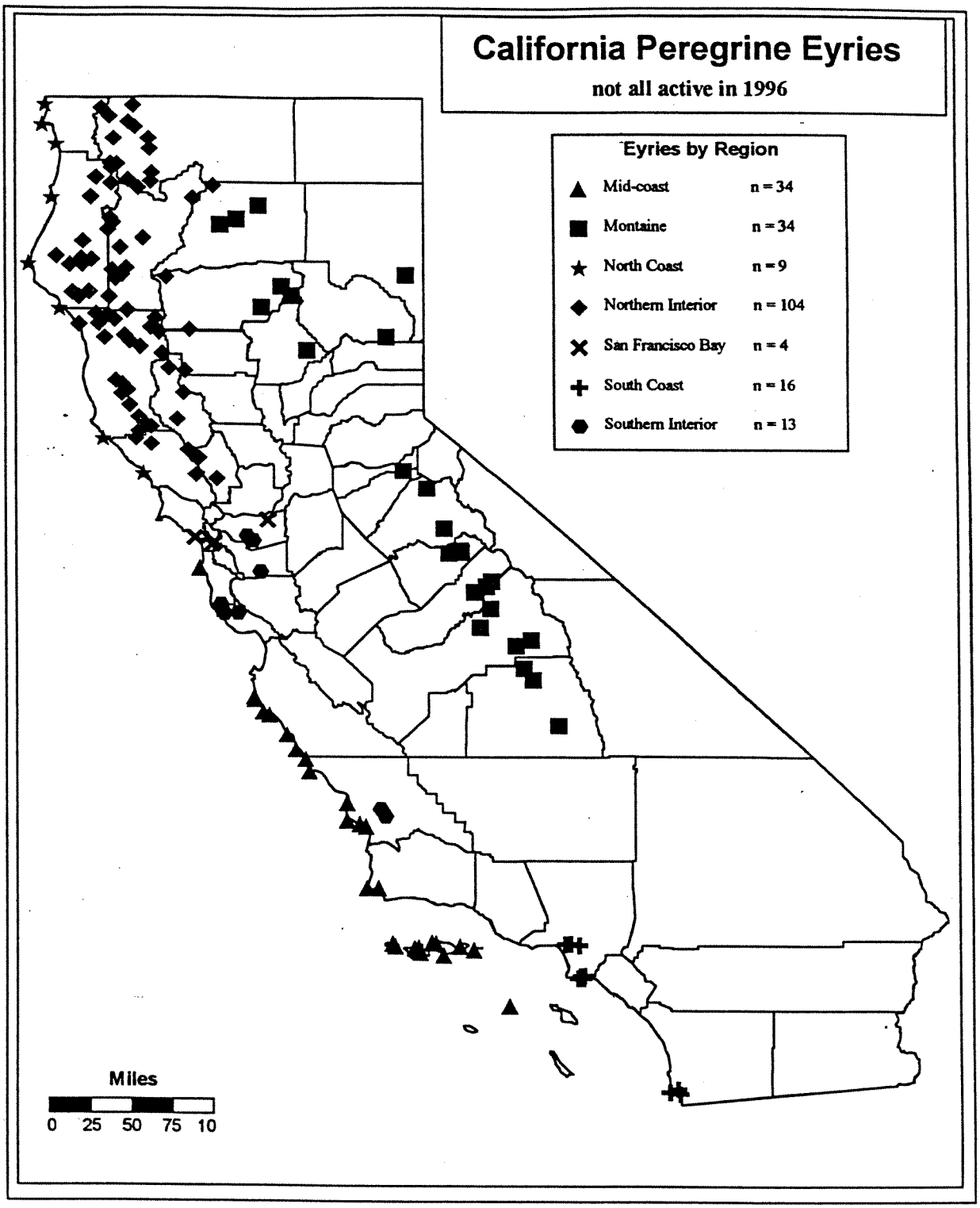


Figure 3. Reoccupation of California Eyries by Five-year Increments.

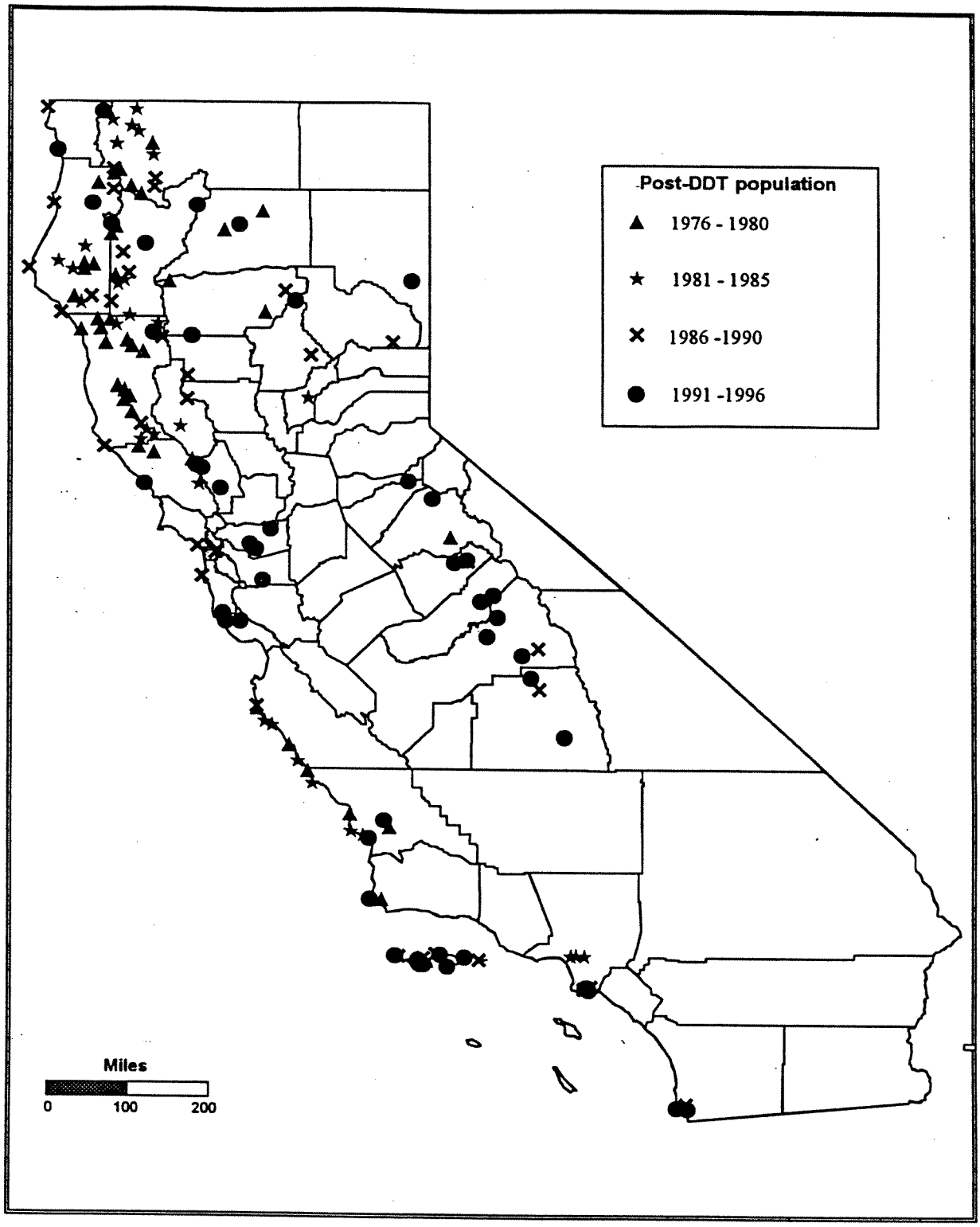


Figure 4. Reoccupation of Central Coastal California by Peregrine Falcons, 1976-1996.

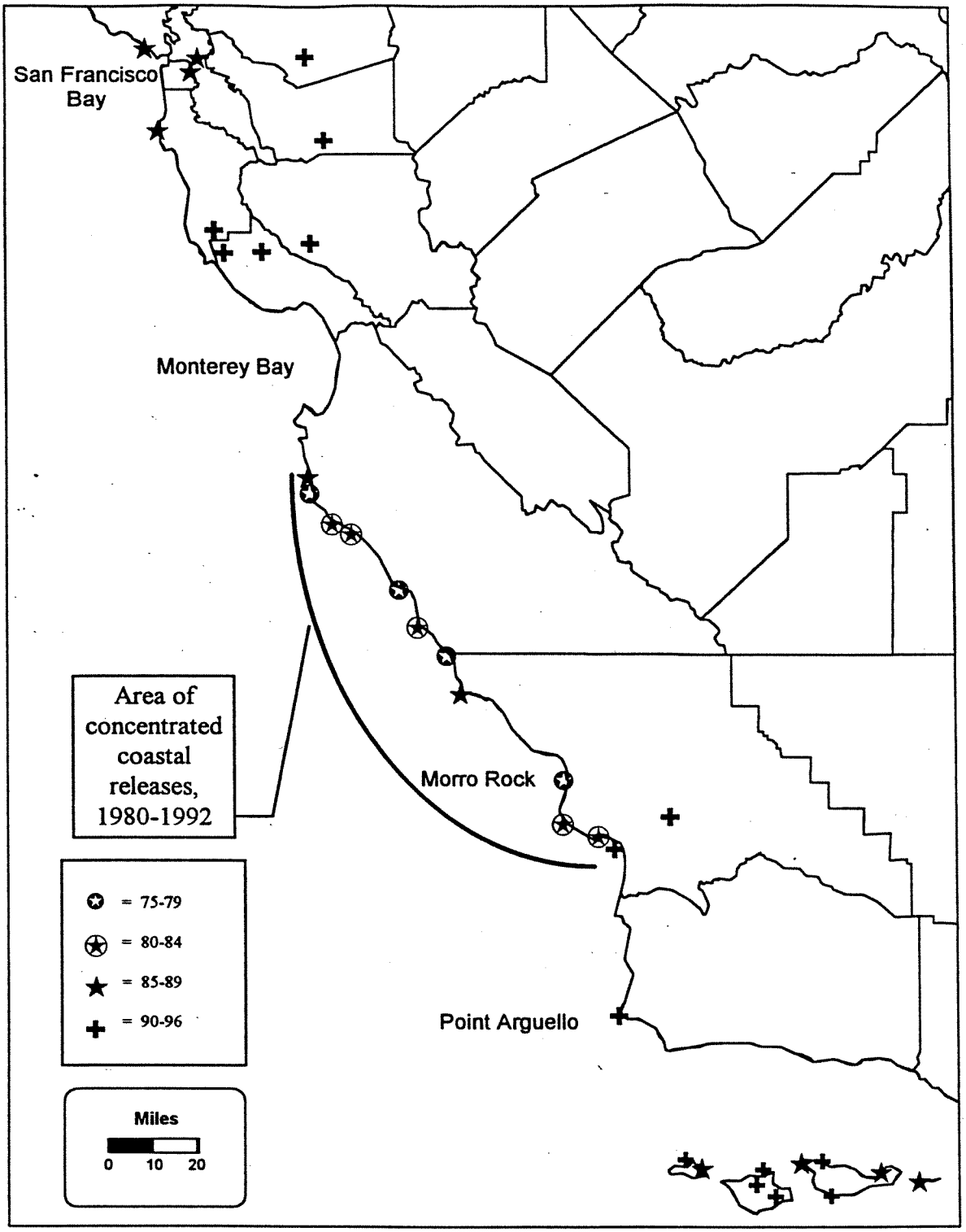
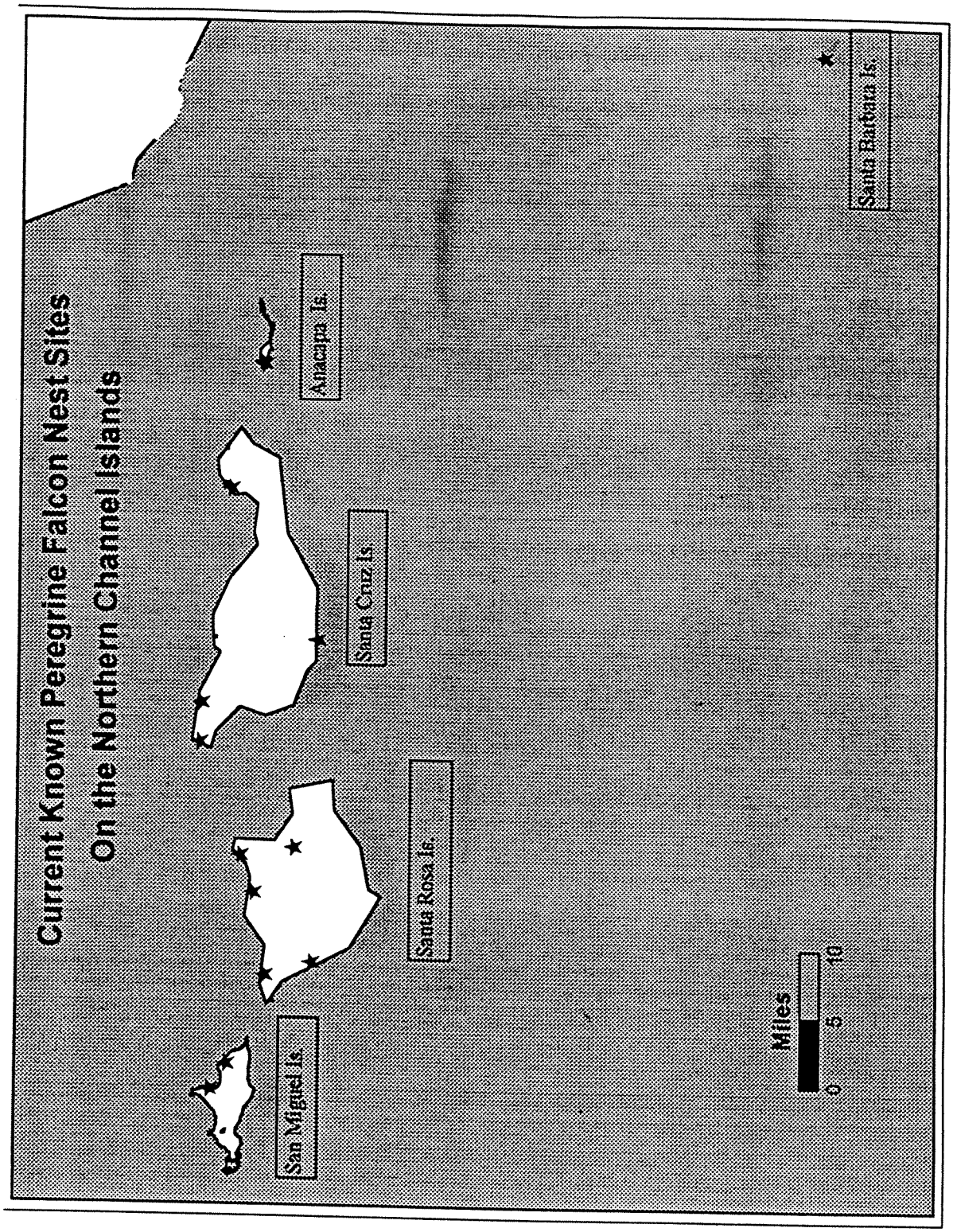


Figure 5. Current Known Peregrine Falcon Nest Sites on the Northern Channel Islands.



Breeding population size is expanding in each region. In the mid-coast region, there is more continuing DDT/DDE impact, and a slower recovery not yet completed. With full State-wide recovery, the number of pairs is expected to exceed 200 in California. Without active management, the rate of recovery of the breeding population and rate of expansion through the entire historic California range would have been reduced significantly. Without restriction of DDT, recovery could not have occurred at all. Eggshell thinning is the only population-decimating factor of overall significance that occurred to cause the peregrine to become endangered with extinction. No other factor potentially affected all individuals and all territories. All other factors should be considered mortality factors affecting individuals, annual productivity at specific sites, and possibly long-term occupancy of individual territories.

## Eggshell Thinning

SCPBRG and associates have conducted observations at hundreds of nests, and have collected eggshells and eggshell fragments from as many nests as feasible every year in California. Eggshells from specimens in museums obtained by egg collectors prior to 1946 are thicker than eggs currently laid by most breeding female peregrines in California.

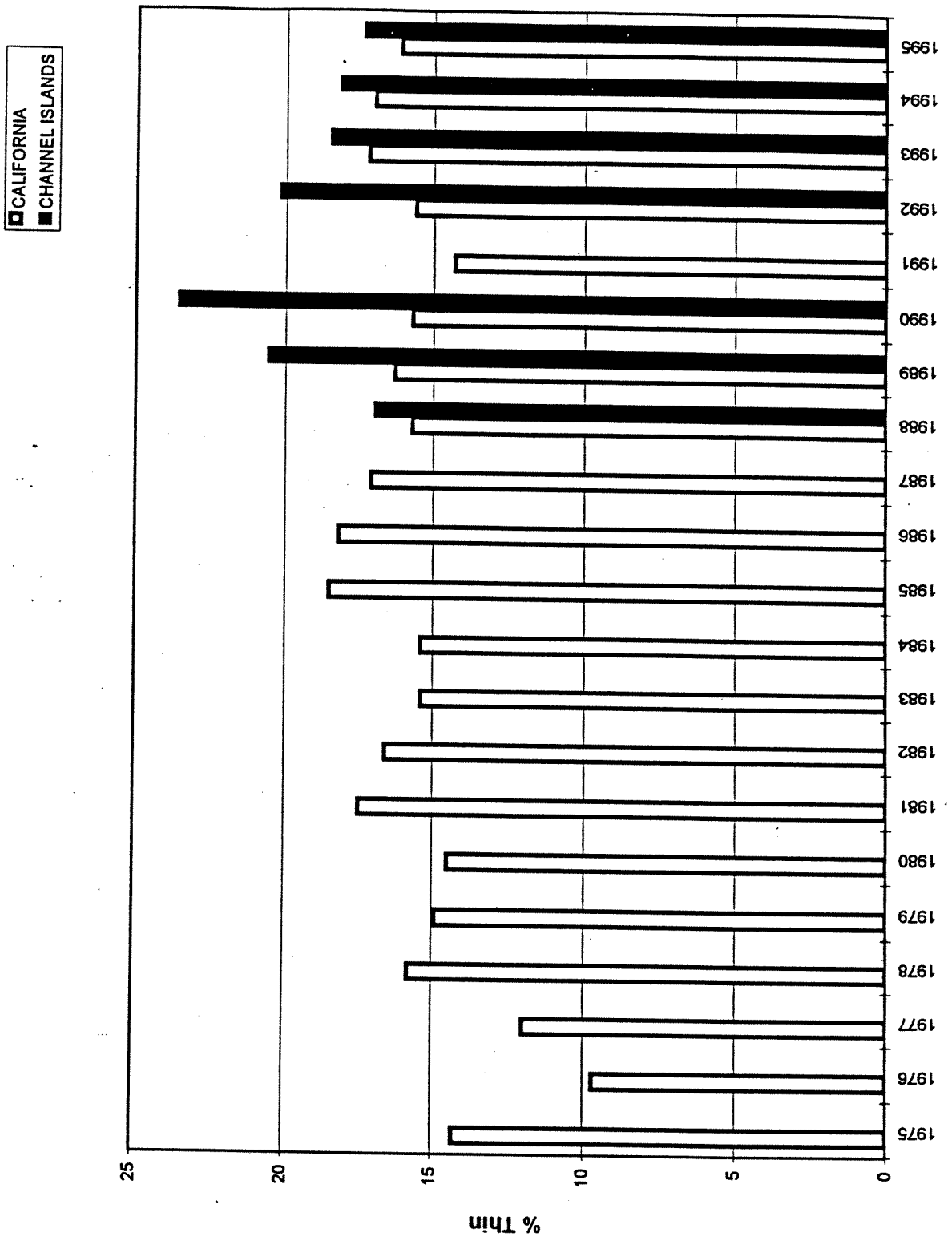
There is no particular point at which an egg is too thin to be incubated successfully, except that eggs that are more than 40% thin are structurally unable to support themselves and hold their contents, so they are likely eaten by female peregrines immediately. Eggs as much as 35 percent thin can be incubated and hatched on occasion. In general, in populations of peregrines worldwide, declines are seen when eggs from the entire study area average over 17% thinner than historic eggshells from that area (Peakall and Kiff 1988). Some eggs with less-severe thinning break, and some exceeding that level survive. The effect of eggshell thinning on overall reduced productivity and population status is seen on a wider scale than individual nests.

All eggs in a clutch do not necessarily measure equal thickness. Some eggs die of "natural" causes, and some die because of pesticides. An egg exceeding the percent thinning associated with population declines may well hatch, but fewer eggs in that range survive incubation.

The average thinning of eggshells collected in California has been near or exceeded levels associated with decline throughout the 1980s and 1990s. Figure 6 depicts eggshell thinning in California over time and eggshell thinning levels from the California Channel Islands specifically. In all years on the Channel Islands as a whole, the average thinning exceeds levels associated with stable, healthy populations, so increased egg loss and less-than-normal productivity is expected.

Falcons that are known to lay very thin eggs and fail repeatedly have been seen to lay shell-less eggs or eggs that break soon after laying. In the late 1950s and 1960s during direct application of DDT in California, egg collecting did not occur at peregrine nests, and peregrine eggs were virtually non-existent. Because no eggs were collected from 1953 through 1969, we do not have eggshell measurements for those years. Observations of similarly polluted peregrines in the 1970s suggest that peregrines laid eggs with shells more than 30% thin during the preceding two decades.

Figure 6. California and Channel Islands Eggshell Thinning Averages Over Time.



In areas where DDT-related failure was greatest or still occurs, with no new application or reduced recycling input, eggshell thinning and productivity is expected to improve in time. Normal eggshell thickness may not be attainable for generations, but with continued protection and restriction of DDT input, eggshell thinning less than 17% for the entire population average is likely to enable recovery to continue. In local areas with continued sources of residual DDT and DDE, reproduction may be depressed for many years and territories in those regions will be dependent on immigration from less-polluted areas.

## Restoration Techniques

In California, restoration was enhanced by three hands-on management techniques. These were fostering, hacking, and cross-fostering.

Fostering of young peregrines into newly reoccupied, yet failing peregrine nests was a technique used on the mainland, and also the Channel Islands. Thin-shelled eggs were removed from wild nests for safe incubation in the laboratory, and captive-hatched young were then fostered into the nests to fledge from the nesting territory.

Hacking was used to expand the range of the remnant population into areas of extirpation. This technique was used on the mainland and the Channel Islands, and continues into 1997. Figures 6-8 depict hack sites for each island where hacking occurred, and Tables 2-4 show results of the hacking procedure.

Cross-fostering, wherein young peregrines were placed in wild prairie falcon nests, was not used on the Channel Islands. While it was successful on the mainland, no prairie falcons nested on the Channel Islands, so this technique was not used there. It is possible that some of the many peregrines of as-yet unidentified origin nesting on the Channel Islands were originally released by cross-fostering on the mainland.

## Hacking

When the peregrine decline was severe, the goal was to increase productivity and increase population size. This was feasible for peregrines since they, unlike most endangered species, were not being eliminated by loss of habitat. Instead, peregrine eggs were being damaged by a physiological phenomenon whereby the chemical DDT, or its metabolite DDE, surprisingly caused a biological misfunction wherein calcium movement from the birds to the eggshells was inhibited, causing thin-shelled eggs to be laid. Thin-shelled eggs were accidentally broken by the incubating falcons at a much higher rate than were eggs of peregrines in the pre-DDT era. Broken eggs meant a reduced number of, or no, fledglings. This translated down the various levels of the peregrine population as there were fewer fledglings, then fewer surviving immatures, then fewer floaters, and lastly near extinction of breeders. Vast areas experienced extirpation when no nests 10 to 150 miles from many territories produced fledglings to be recruited to reoccupy nests where fatality of an existing breeding adult occurred. As a result, unlike in the case of most endangered species, a vast amount of available breeding habitat existed to be reoccupied.

In order to re-establish a large, interacting population with dispersal and then recruitment into vast areas of extinction, "hacking" of fledglings over a wide area was required. The Channel Islands were included in this effort. The goal of the Channel Islands National Park, and both the State and Federal Endangered Species Acts included recovery everywhere, but productivity goals were for a

population average, not on a per nest basis. Therefore hacking was and is an appropriate management tool to restore and maintain Channel Island territories. Hacking began on the Channel Islands in 1983 and continued to 1988. It began again in 1997 to fully re-establish territories despite DDT impacts that continue.

Hacking is a modified falconry technique used since medieval times when fledgling falcons were removed from nests, placed on a hilltop on a "hack" (wooden, horse-drawn cart) and fed while they exercised and learned to fly with no adults present. They relied on the hack cart for food and were eventually trapped there and used for falconry purposes.

Biologists use a "hack" box, feed the peregrines surreptitiously, and do not trap the fledglings. This process allows the youngsters to gain independence, establishing a region of natal origin where no adults are present. The falcons then disperse as peregrines instinctively do, and later seek nest territories within roughly 10 to 150 miles of their point of natal origin. The following tables and figures show the histories and locations of hack sites on the Channel Islands. Falcons listed as reaching independence are those that remained in the area of the hack box and fed there until they reached independence and dispersed. Early dispersals are falcons that disappeared from the site before the usual dependency period of approximately four to six weeks post-fledging had passed. Because some early dispersing falcons have survived to become breeders in California, they are not listed as not reaching independence, since their fate is unknown. Those listed as not reaching independence are known to have died prior to dispersing from the site.

To prevent extinction, the goal is to first re-establish a breeding population, then to re-establish productivity. Ideally, that process would be reversed, but under the circumstances it was the only option for peregrines. When hacking began, DDT-caused failure was common and critics said hacking would not work or that it was a waste of resources.

The possibility that DDT would continue to cause reproductive failure did not reduce the importance of our goal of re-establishing a breeding population. A failing population was an improvement over extinction, and preserved the genetic potential of the population, in contrast to what happened when the East Coast race of the peregrine went extinct before any management could be attempted. We used hacking on the Channel Islands to meet these goals. Tables 2-4 and Figures 6-8 detail the history and locations of hack sites on the Channel Islands.

Table 2. History of San Miguel Island Hack Site.

A hack site was conducted at Cuyler Harbor on San Miguel Island in 1985 and 1986. One of the males released in 1985 has been a resident ever since.

| Year Released | Falcons Reaching Independence | Falcons Not Reaching Independence | Early Dispersals | Notes |
|---|---|---|---|---|
| 1985 | | | | |
| | M | | | Breeds on island. |
| | M | | | |
| | F | | | |
| 1986 | | | | |
| | M | | | |
| | M | | | |
| | | M | | This bird was shot. |

Figure 6. San Miguel Island Hack Site.

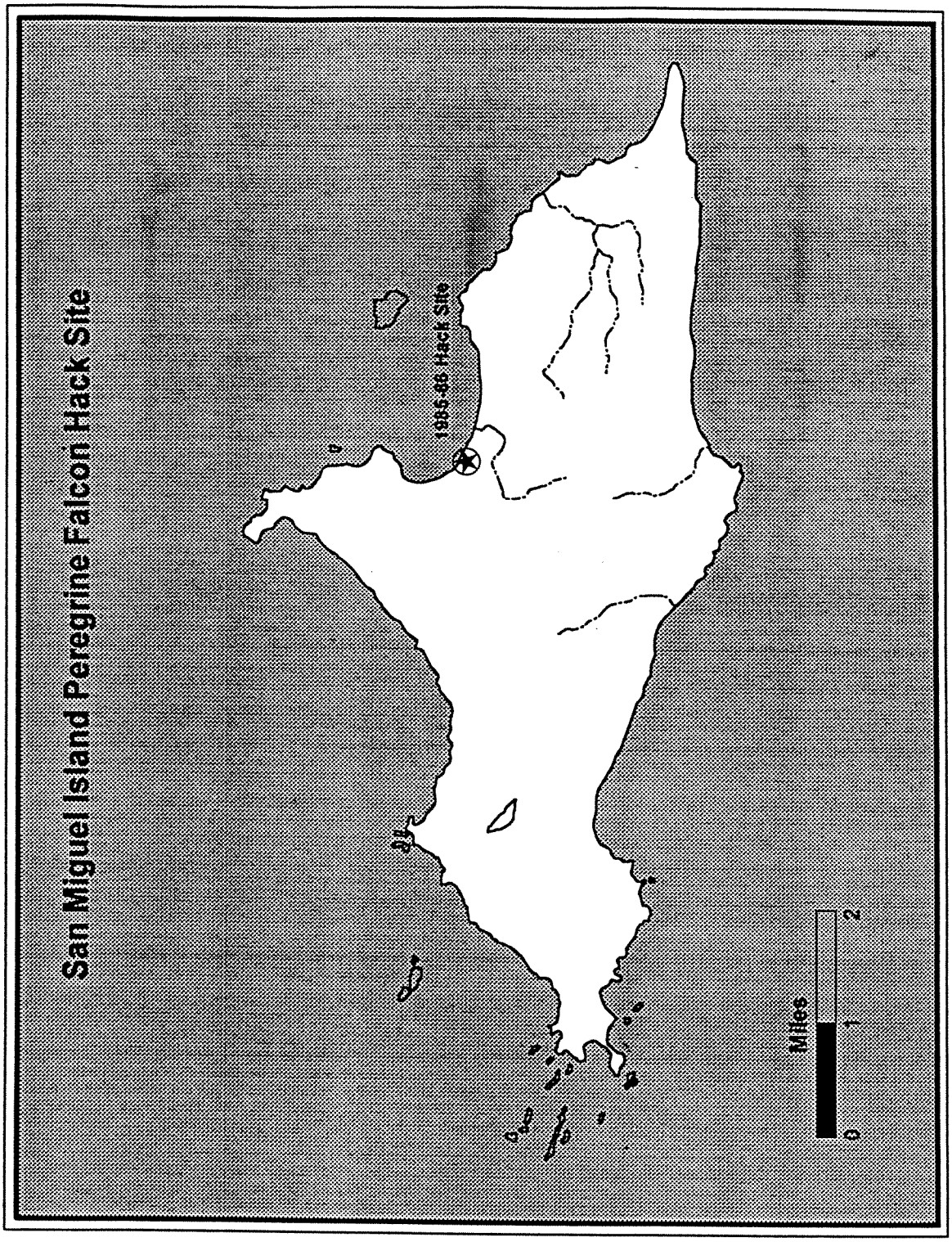


Table 3. History of Santa Catalina Island Hack Site.

A hacksite was conducted on Santa Catalina Island in 1983-1988. One of the females released in 1988 bred in Long Beach, CA.

| Year Released | Falcons Reaching Independence | Falcons Not Reaching Independence | Early Dispersals | Notes |
|---|---|---|---|---|
| 1983 | | | | |
| | F | | | |
| | F | | | |
| | | | F | |
| 1984 | | | | |
| | F | | | |
| | F | | | |
| | | | F | |
| 1985 | | M | | Killed by predator. |
| | | M | | Killed by red-tailed hawk. |
| | F | | | |
| | F | | | |
| 1987 | | | | |
| | M | | | |
| | F | | | |
| | M | | | |
| 1988 | | | | |
| | F | | | Bred in Long Beach |
| | F | | | |
| | M | | | |

Figure 7. Santa Catalina Island Hack Sites.

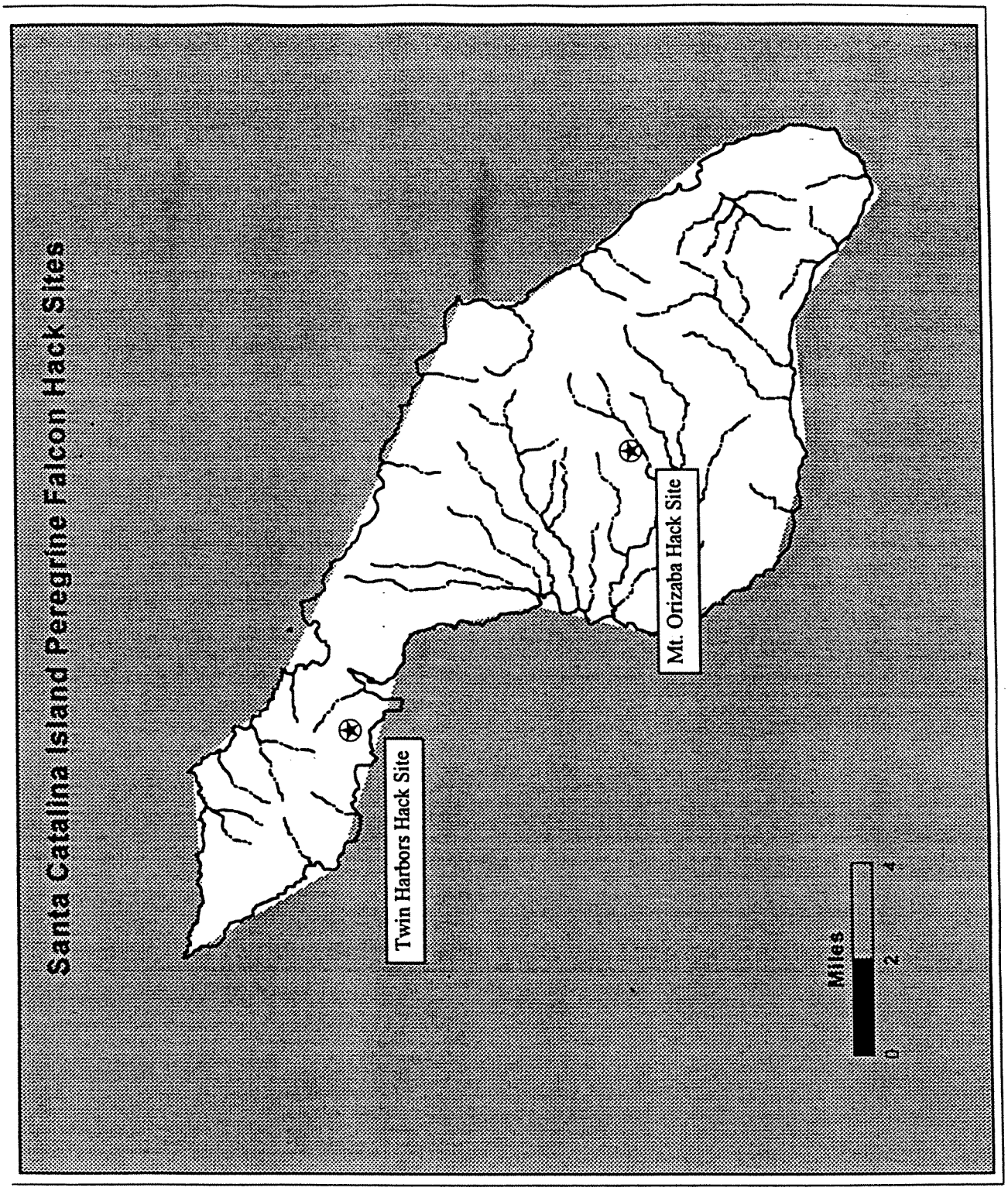
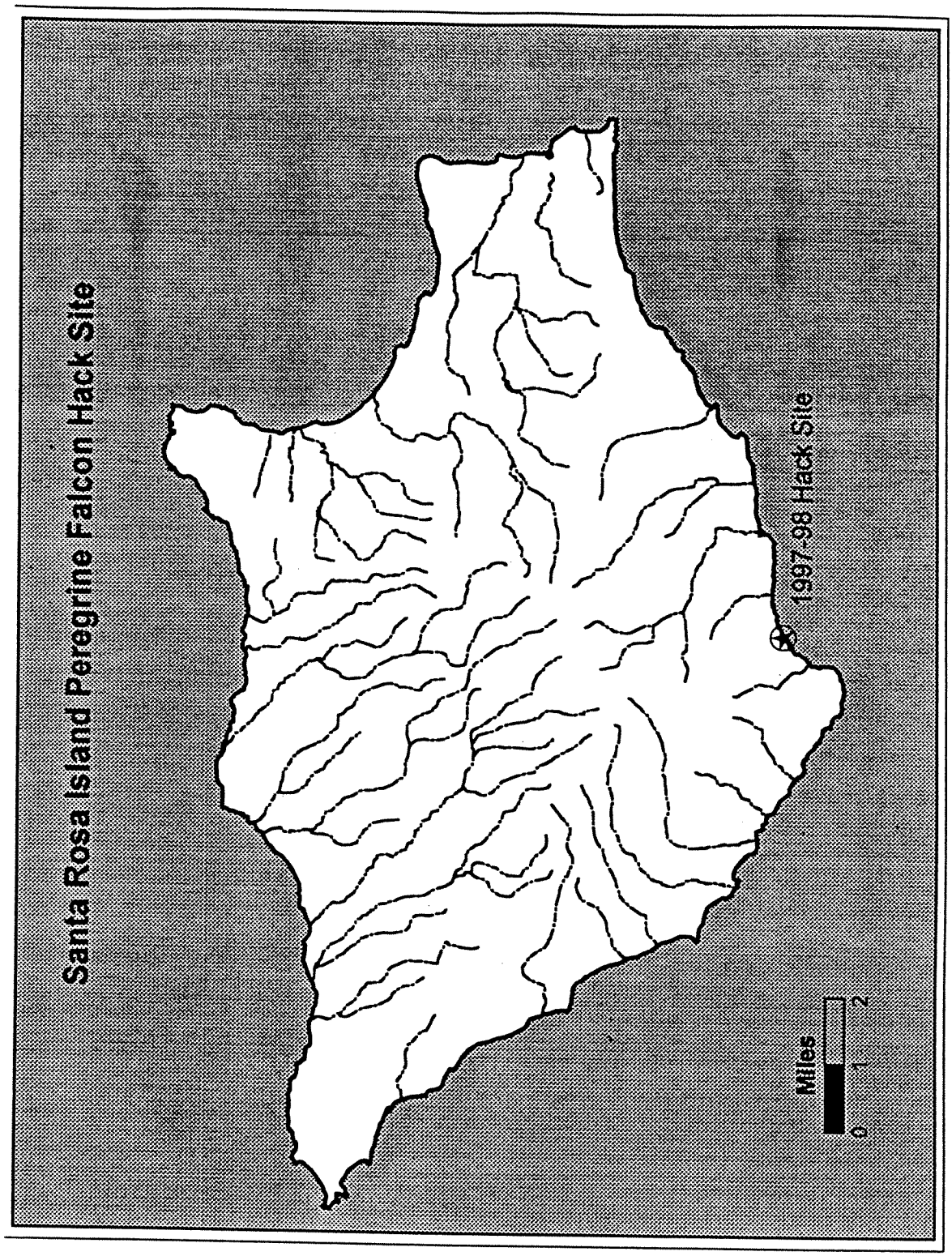


Table 4. History of Santa Rosa Island Hack Site.

A hack site was conducted on Santa Rosa Island in 1997. This is the first time peregrines have been hacked on Santa Rosa. This site will be used in 1998-2000, with the release of 50+ falcons expected.

| Year Released | Falcons Reaching Independence | Falcons Not Reaching Independence | Early Dispersals | Notes |
|---|---|---|---|---|
| 1997 | F | F | | |

Figure 8. Santa Rosa Island Hack Site.



By the 1980s, when hacking and other release techniques were used to reestablish a large number of falcons, it was clear that DDT still had an impact. It is generally understood that in other areas farther from local sources, productivity was somewhat reduced by DDT built up over time in older females, but that productivity otherwise would be higher in those areas. With reduction in shooting, and general protection of falcons and habitat, productivity even slightly reduced by DDT over a large area (continental U.S.A.) could still result in birds to help disperse and thus maintain breeding territories in areas of high DDT impact, for example Big Sur or the Channel Islands.

## Number of Birds Released

The hands-on recovery effort has resulted in a vast amount of data. This includes behavioral information; wide-scale observation of territory occupancy and productivity; and collection and analysis of egg contents, eggshells, blood, and prey remains. Peregrines of various ages were banded and later retrapped to determine general movements and fledgling dispersal. Young falcons were released into the wild by various means to increase productivity and expand the breeding range into areas of extirpation. These activities were major facets of the overall recovery effort. Table 5 and Figure 8 show the number of peregrines released in California, and their numbers relative to wild-fledged young.

As described above, the three release techniques used are called hacking, fostering, and cross-fostering. The first two were used on the Channel Islands. Released young were from three main sources. These include captive-bred falcons, those hatched in captivity from thin-shelled wild eggs, and those translocated from nests normally experiencing high mortality of fledglings (buildings, bridges, pigeon-fancier problem areas). Through 1997, over 750 young peregrines were released in California to augment wild peregrine productivity. Releases were conducted in areas 10 to 150 miles from adjacent territories to stimulate dispersal into areas of extirpation.

## Recovery Dynamics on the Channel Islands

In California, the restoration effort is working to increase the rate of recovery and expand the remnant population into regions remaining unoccupied, both on the mainland and the Channel Islands. Tables 6-18 detail the history of recent nesting territories on each island indicating the year of discovery of reoccupancy, and productivity for that nest site. A sample of breeding adults on the Channel Islands have been trapped and their bands read to reveal their origin. Figures 10-19 show these birds' origins and their eventual breeding locations, and fledglings from Channel Island hack sites that have been trapped elsewhere. Time and funding do not allow banding of all individuals in California nests or trapping of all banded breeding adults. The records therefore represent a sample of dispersal.

Table 5. Number of Peregrine Falcons Released In California, 1977-1997.

| Type/Method | Number |
|---|---|
| Fostered | 297 |
| Cross-Fostered | 107 |
| Hacked through 1992 | 296 |
| Hacked 1995-1996 | 32 |
| Hacked in 1997 | 22 |
| **TOTAL:** | **754** |

Figure 9. Origin of California Fledglings, Wild- vs. Captive-hatched, 1975 - 1992.

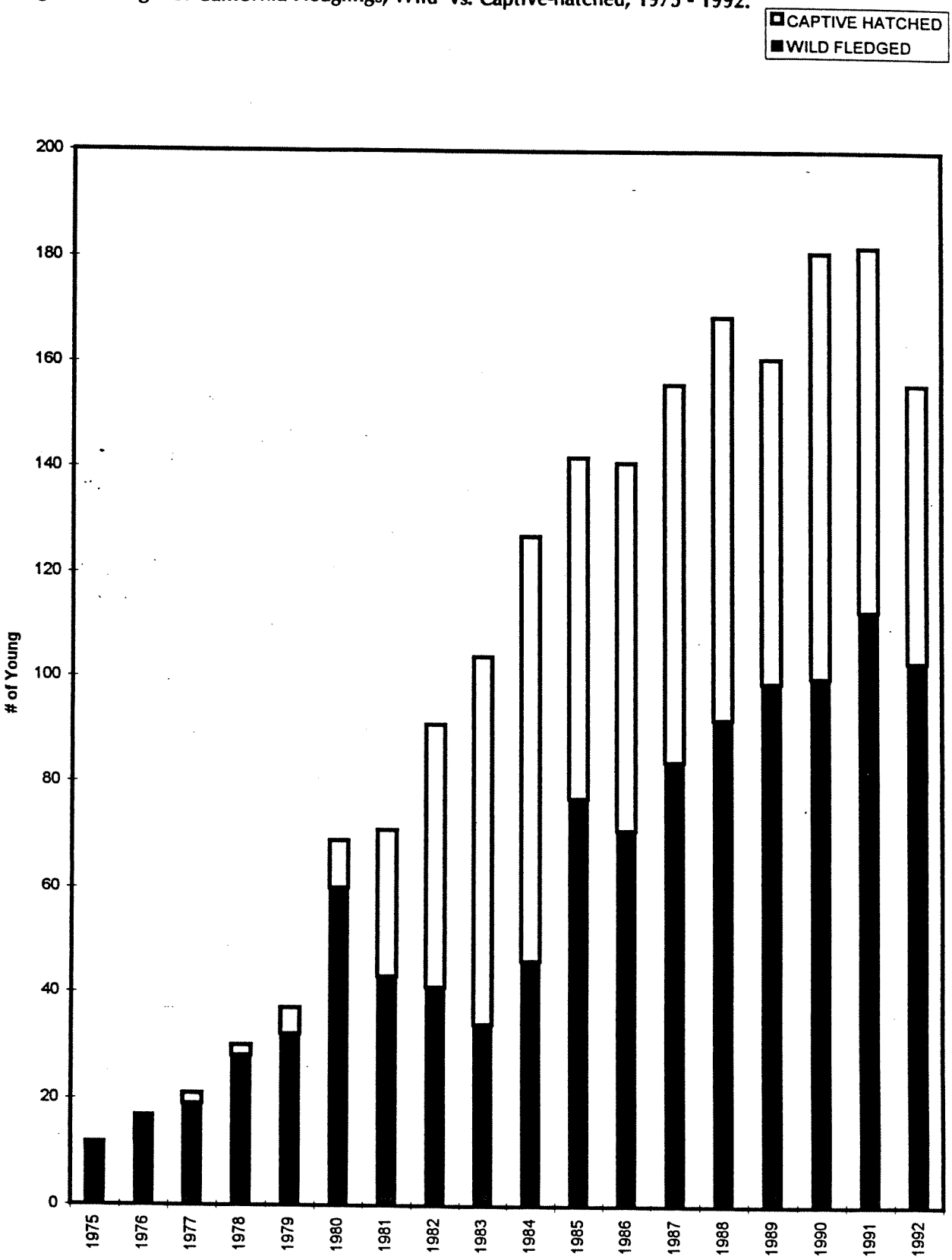


Table 6. History of MC-21, West Anacapa Island.

| Year | Status | Outcome | Comments |
|---|---|---|---|
| 1988 | | | visited, no falcons seen |
| 1989 | Active | 3 young | |
| 1990 | Active | 3 young | |
| 1991 | Active | 2 young | |
| 1992 | Active | 3 young | first clutch removed, 2 of 4 hatched in lab |
| 1993 | Active | 2 young | |
| 1994 | Active | 2 young | |
| 1995 | Active | unknown | believed to have failed |
| 1996 | Active | unknown | believed to have failed |
| 1997 | Active | unknown | to be determined |

Figure 10. Origin of Anacapa Island Breeding Adults.

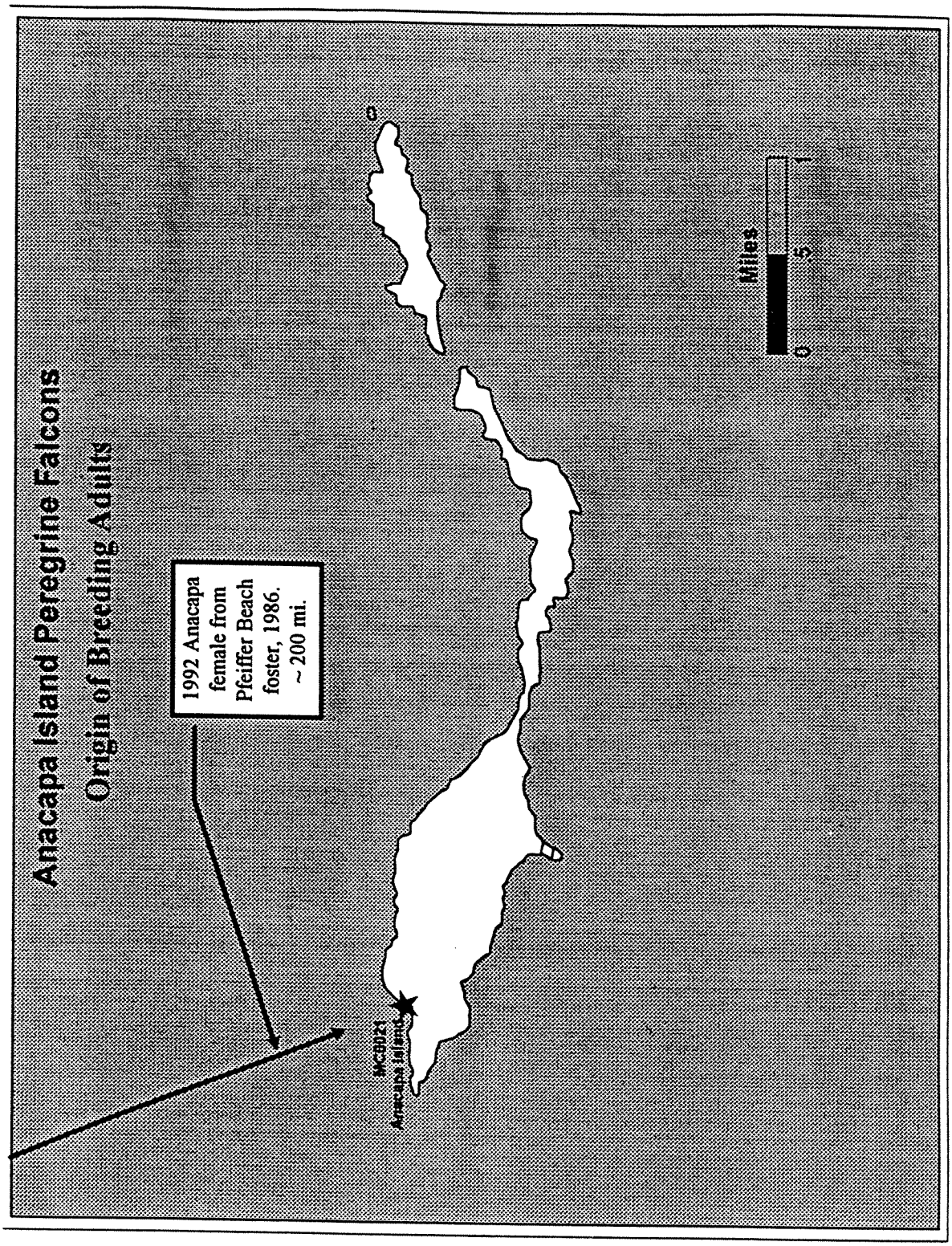


Figure 11. Dispersal of Anacapa Island Fledglings.

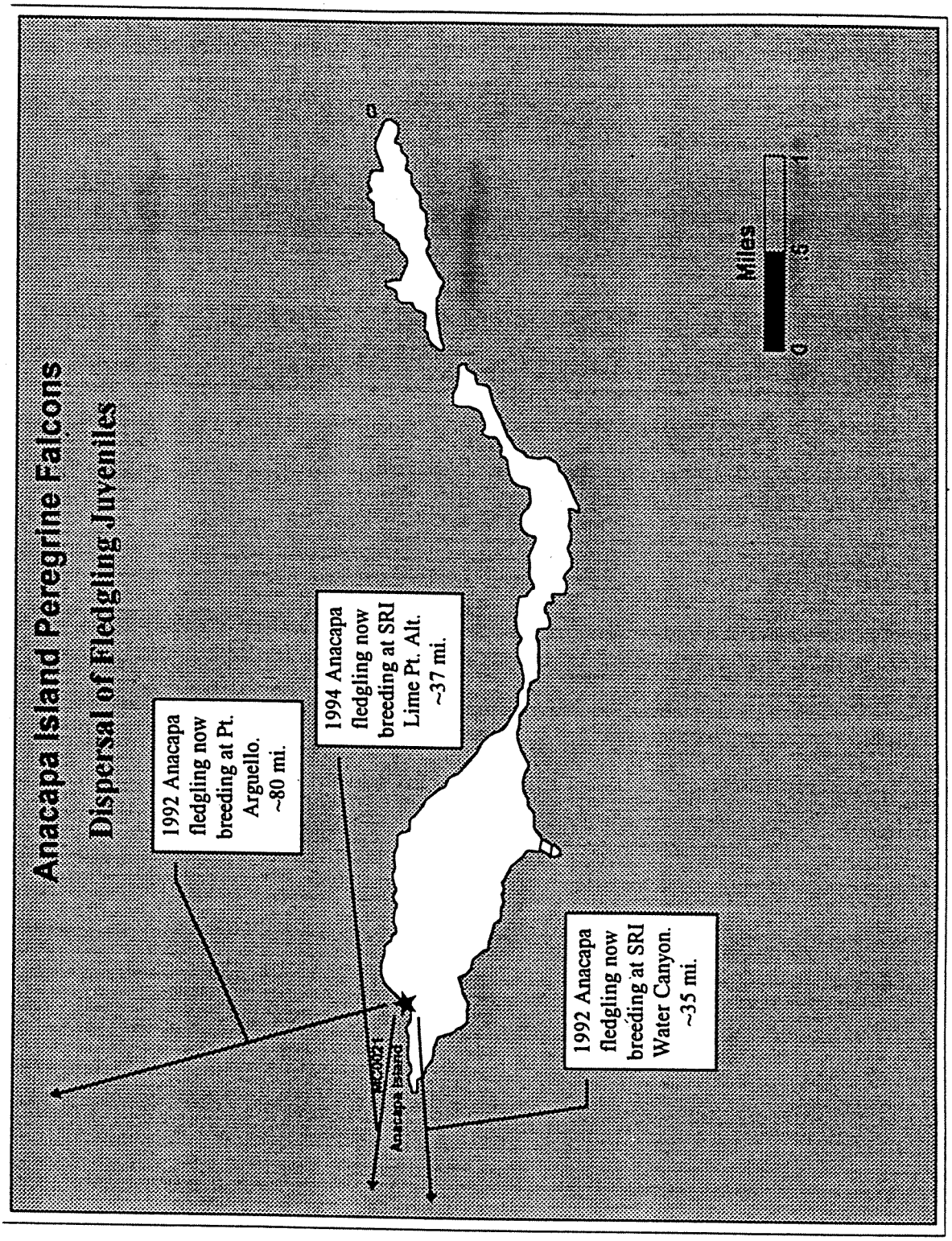


Table 7. History of MC-28, Bat Rock on San Miguel Island.

| Year | Status | Outcome | Comments |
|---|---|---|---|
| 1992 | Active | 0 young | fostered young disappeared, 2 eggs removed, did not hatch |
| 1993 | Active | 0 young | |
| 1994 | Active | 2 young | |
| 1995 | Active | - | probable young |
| 1996 | Active | 1+ young | at least one young produced |
| 1997 | Active | 1+ young | at least one young produced |

Table 8. History of MC-17, Hoffman Point on San Miguel Island.

| Year | Status | Outcome | Comments |
|---|---|---|---|
| 1986 | | | one-year-old hacked bird seen with one-year-old unbanded female at hacksite |
| 1987 | Active | 0 young | pair observed, no young produced |
| 1988 | Active | 0 young | pair observed, no young produced |
| 1989 | Active | 2 young fostered | dead eggs replaced with 2 chicks |
| 1990 | Active | 1 young | 2 dead eggs removed |
| 1991 | (Active) | | presumed active |
| 1992 | Active | 1 young fostered | one young fostered to nest, four eggs did not hatch in lab |
| 1993 | Active | failed | |
| 1994 | Active | failed | |
| 1995 | Active | failed | |
| 1996 | Active | 1+ young | at least one young produced |
| 1997 | Active | unknown | one young heard, possibly from Bat Rock |

Figure 12. Origin of San Miguel Island Breeding Adults.

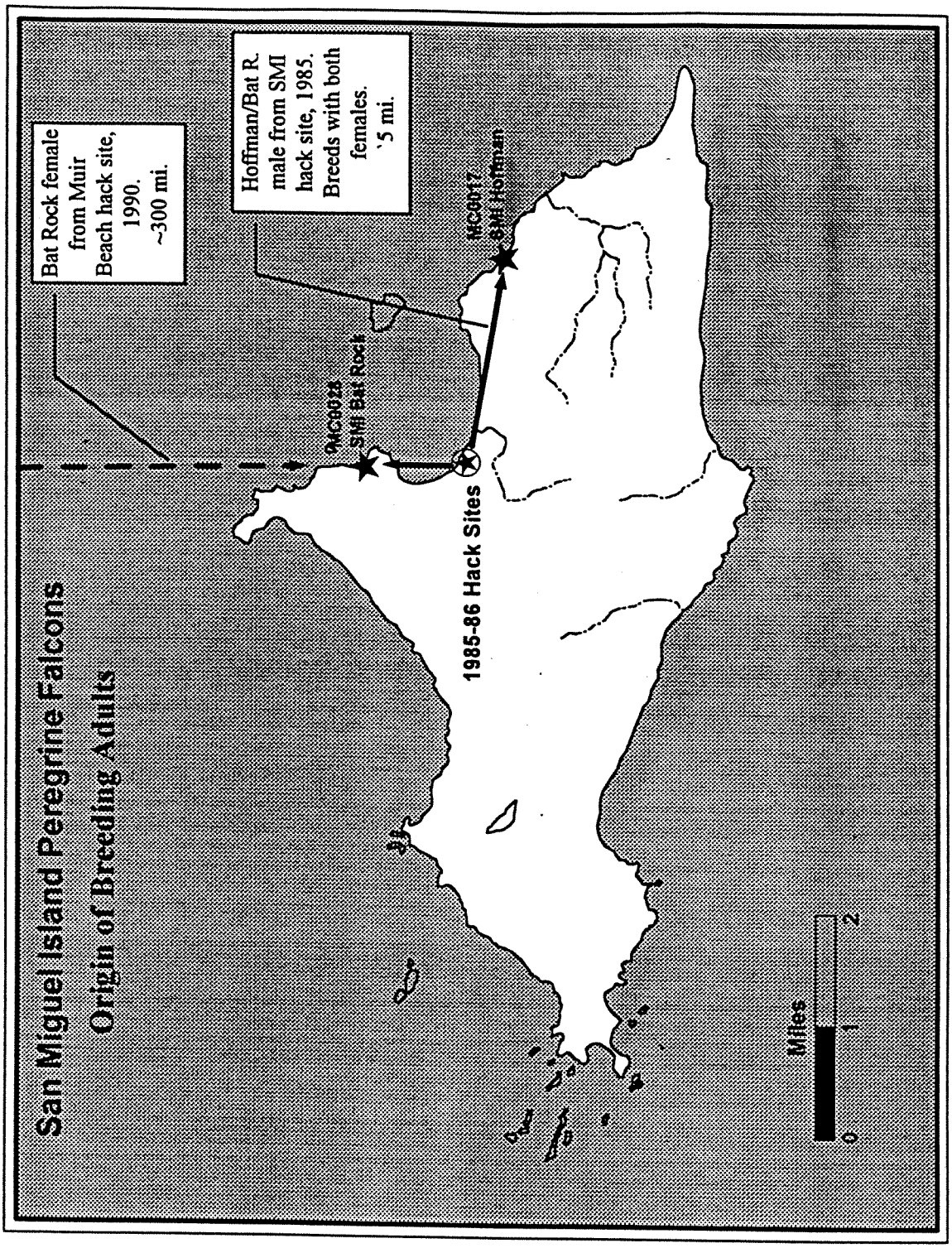


Figure 13. Dispersal of San Miguel Island Juveniles.

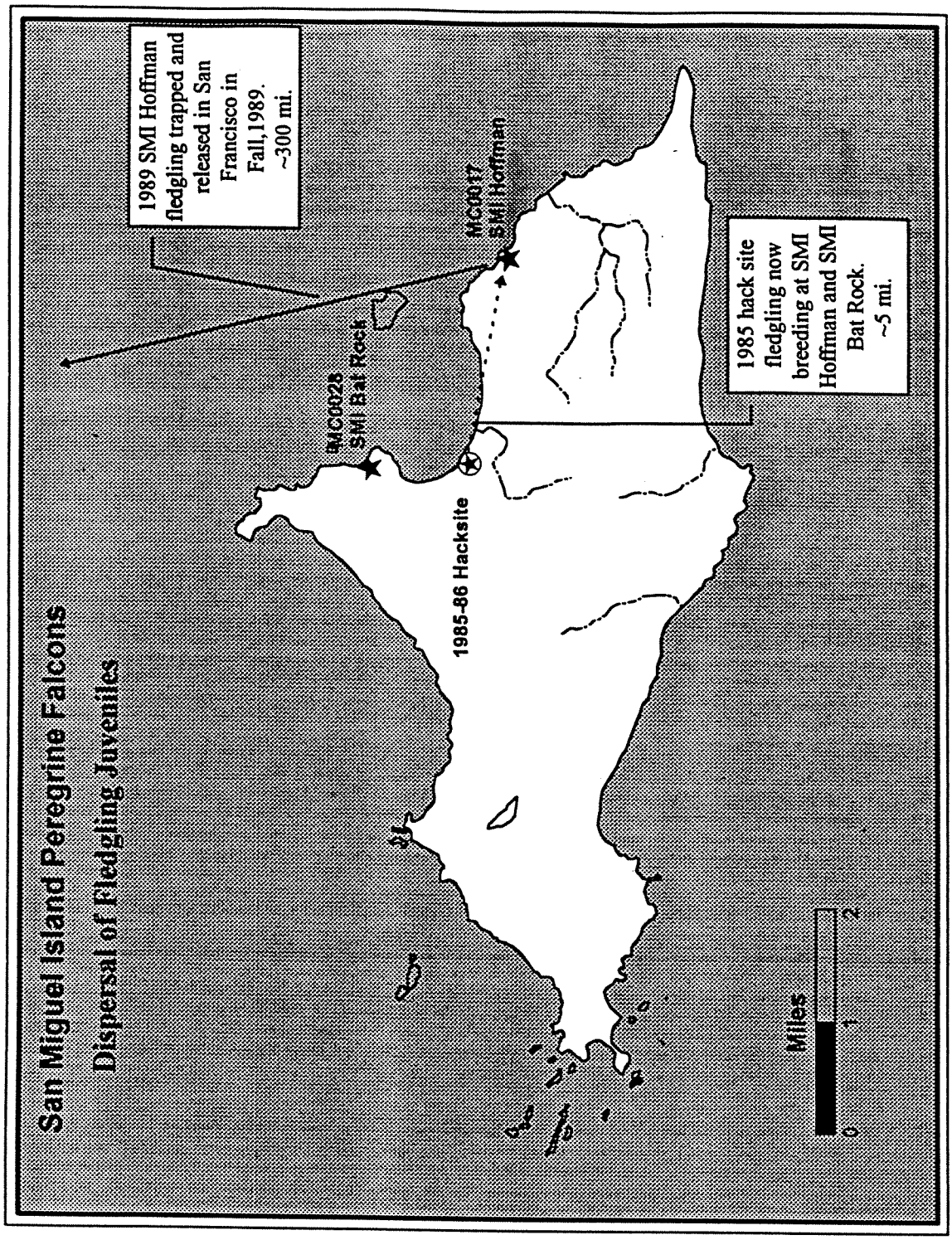


Table 9. History of MC-33, Signal Peak on Santa Barbara Island.

| Year | Status | Outcome | Comments |
|---|---|---|---|
| 1995 | Active | 0 young | adult male and immature female |
| 1996 | Active | unknown | unable to determine outcome |
| 1997 | Active | unknown | laid eggs, unable to determine outcome |

Figure 14. Origin of Santa Barbara Island Breeding Adults.

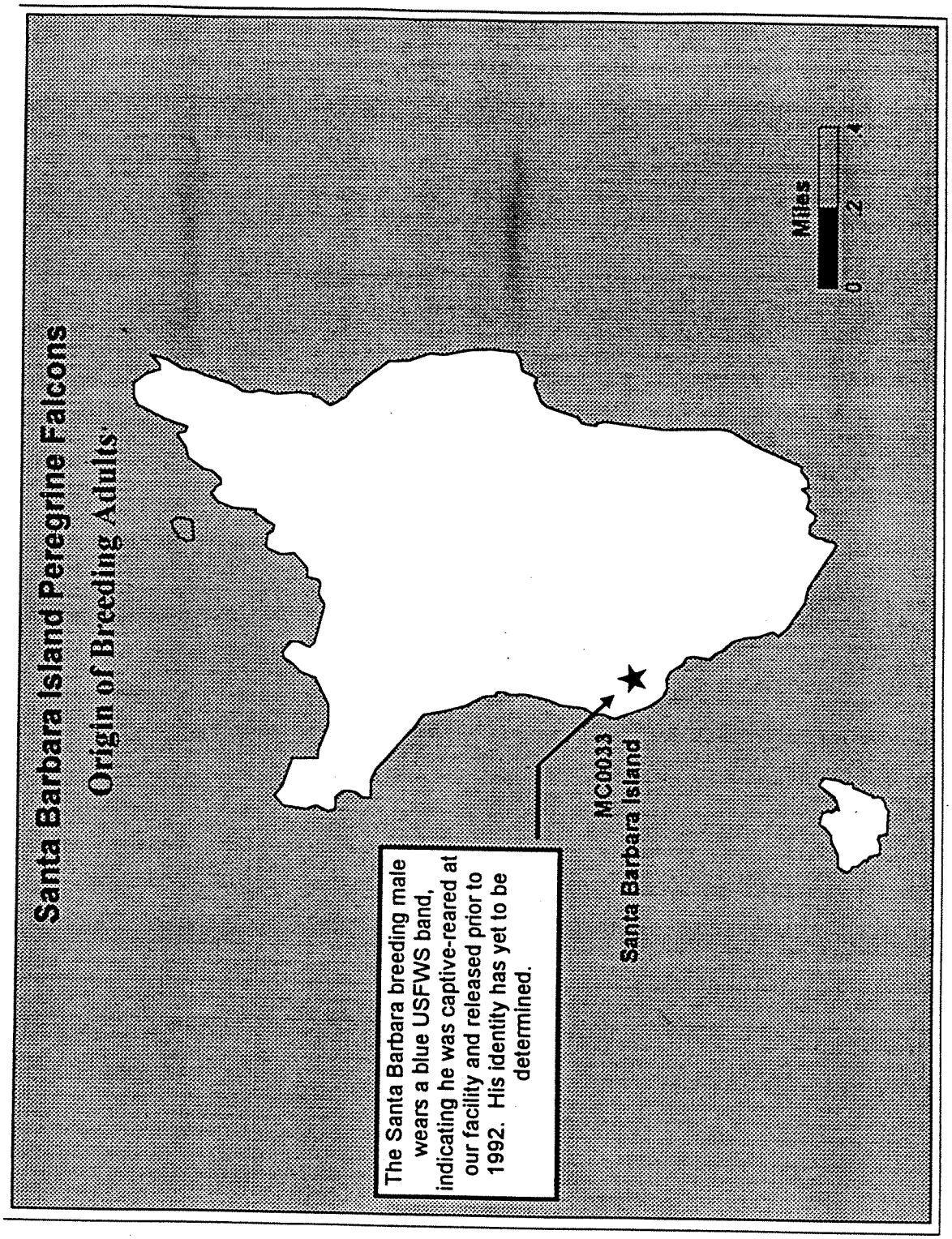


Table 10. History of MC-18, Gherini Nest on Santa Cruz Island.

| Year | Status | Outcome | Comments |
|---|---|---|---|
| 1988 | | | report of bird(s), status unconfirmed, probably active |
| 1989 | | | report of bird(s), status unconfirmed, probably active |
| 1990 | | | report of bird(s), status unconfirmed, probably active |
| 1991 | Active | | adult female and subadult male |
| 1992 | Active | 4 young | 1st clutch removed, none of four eggs hatched |
| 1993 | Active | 3 young | |
| 1994 | Active | 2 young | |
| 1995 | Active | unknown | unable to determine outcome |
| 1996 | Active | 2+ young | at least two young produced |
| 1997 | Active | unknown | unable to determine outcome |

Table 11. History of MC-19, Laguna Canyon on Santa Cruz Island.

| Year | Status | Outcome | Comments |
|---|---|---|---|
| 1989 | | | report of bird(s), checked, inactive |
| 1990 | | | not visited |
| 1991 | (occupied) | | one falcon seen, no nesting found |
| 1992 | Active | 1 young fostered | two eggs removed, one hatched |
| 1993 | Active | 1+ young | at least one young produced |
| 1994 | Active | 0 | possible new male, no young |
| 1995 | Active | 1 young | |
| 1996 | inactive? | | apparently inactive |
| 1997 | Active | unknown | unable to determine outcome |

Table 12. History of MC-20, West End on Santa Cruz Island.

| Year | Status | Outcome | Comments |
|---|---|---|---|
| 1989 | Active | 2 young fostered | one egg removed, hatched in lab |
| 1990 | Active | 2 young | |
| 1991 | Active | | unable to determine outcome, probably failed |
| 1992 | Active | 2 young | first clutch removed, 2 of four hatched in lab |
| 1993 | Active | 3 young | |
| 1994 | Active | 1 young | |
| 1995 | Active | 3 young | |
| 1996 | Active | 3 young | |
| 1997 | Active | unknown | unable to determine outcome |

Table 13. History of MC-30, Sea Lion on Santa Cruz Island.

| Year | Status | Outcome | Comments |
|---|---|---|---|
| 1993 | Active | 3 young | |
| 1994 | Active | 0 young | failed |
| 1995 | | | unable to determine |
| 1996 | Active | 0 young | one-year old female |
| 1997 | Active | 2 young | |

Figure 15. Origin of Santa Cruz Island Breeding Adults.

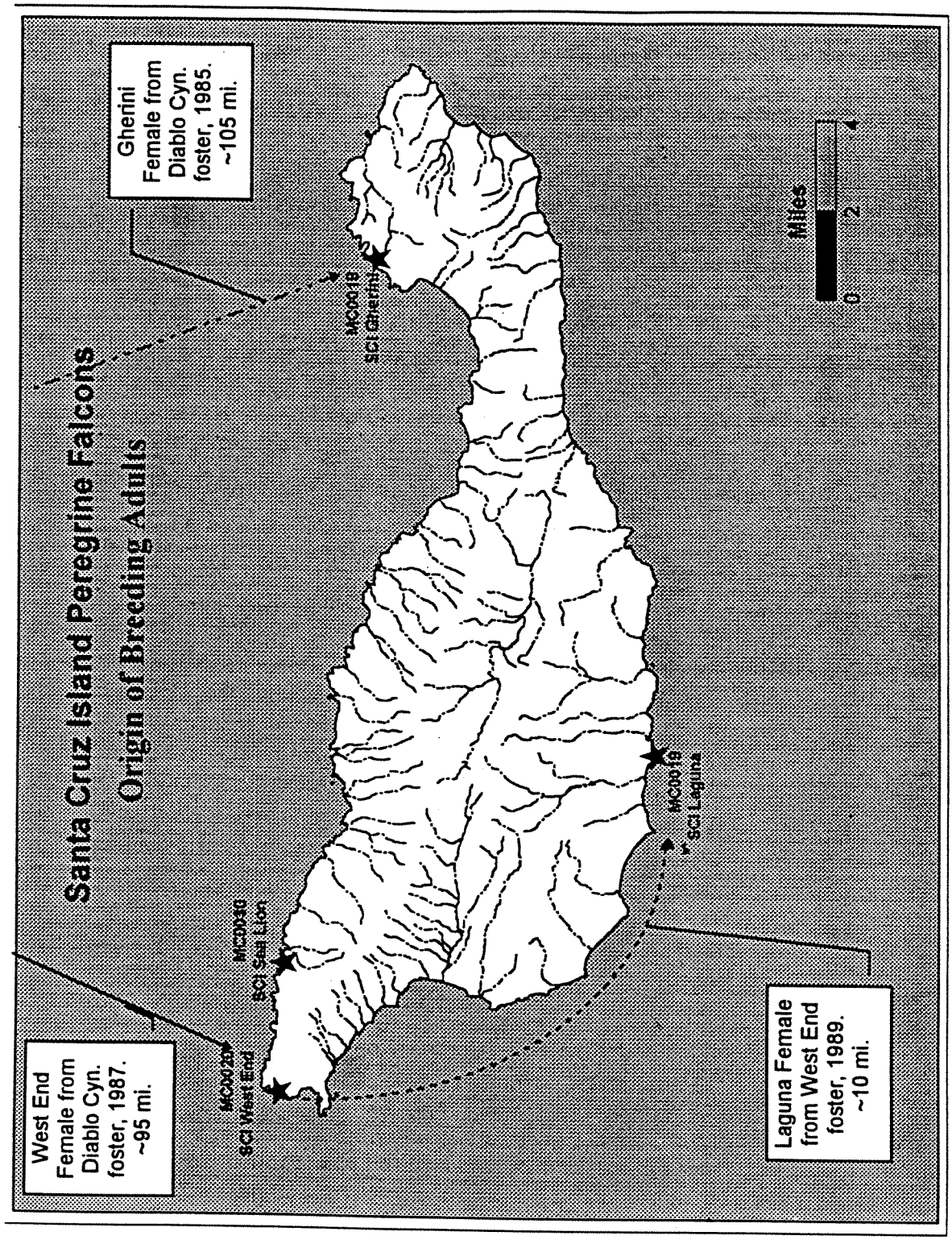


Figure 16. Dispersal of Santa Cruz Island Juveniles.

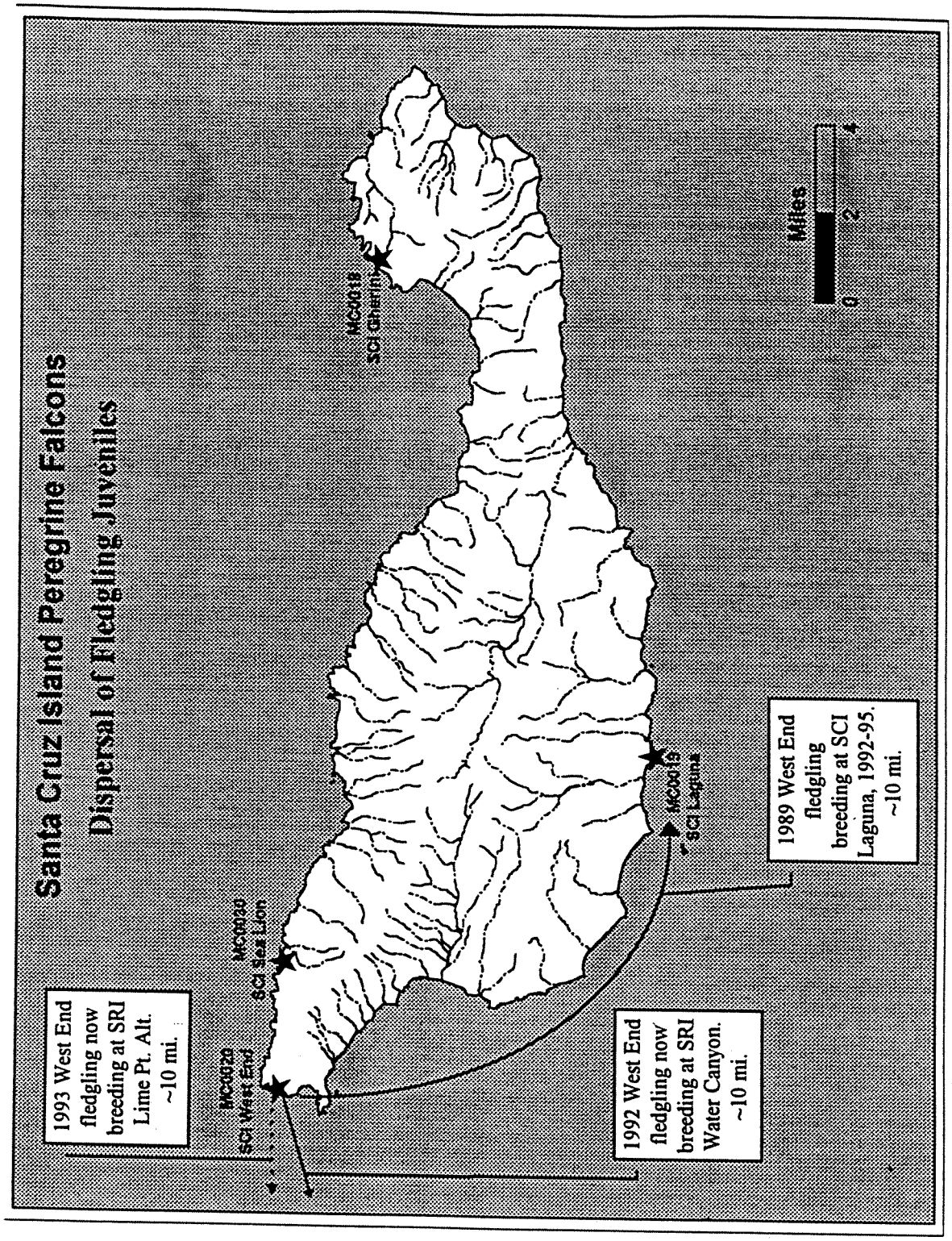


Table 14. History of MC-27, Lime Point on Santa Rosa Island.

| Year | Status | Outcome | Comments |
|---|---|---|---|
| 1992 | Active | unknown | 1 addled egg collected |
| 1993 | Active | 0 young | female died, replaced by subadult |
| 1994 | Inactive | | |
| 1995 | Inactive | | |
| 1996 | Active | | subadult female |
| 1997 | Active | 2 young | moved to Lobos Canyon |

Table 15. History of MC-31, Water Canyon on Santa Rosa Island.

| Year | Status | Outcome | Comments |
|---|---|---|---|
| 1995 | Active | 3 young | |
| 1996 | Active | 3 young | |
| 1997 | Active | 4 young | |

Figure 17. Origin of Santa Rosa Island Breeding Adults.

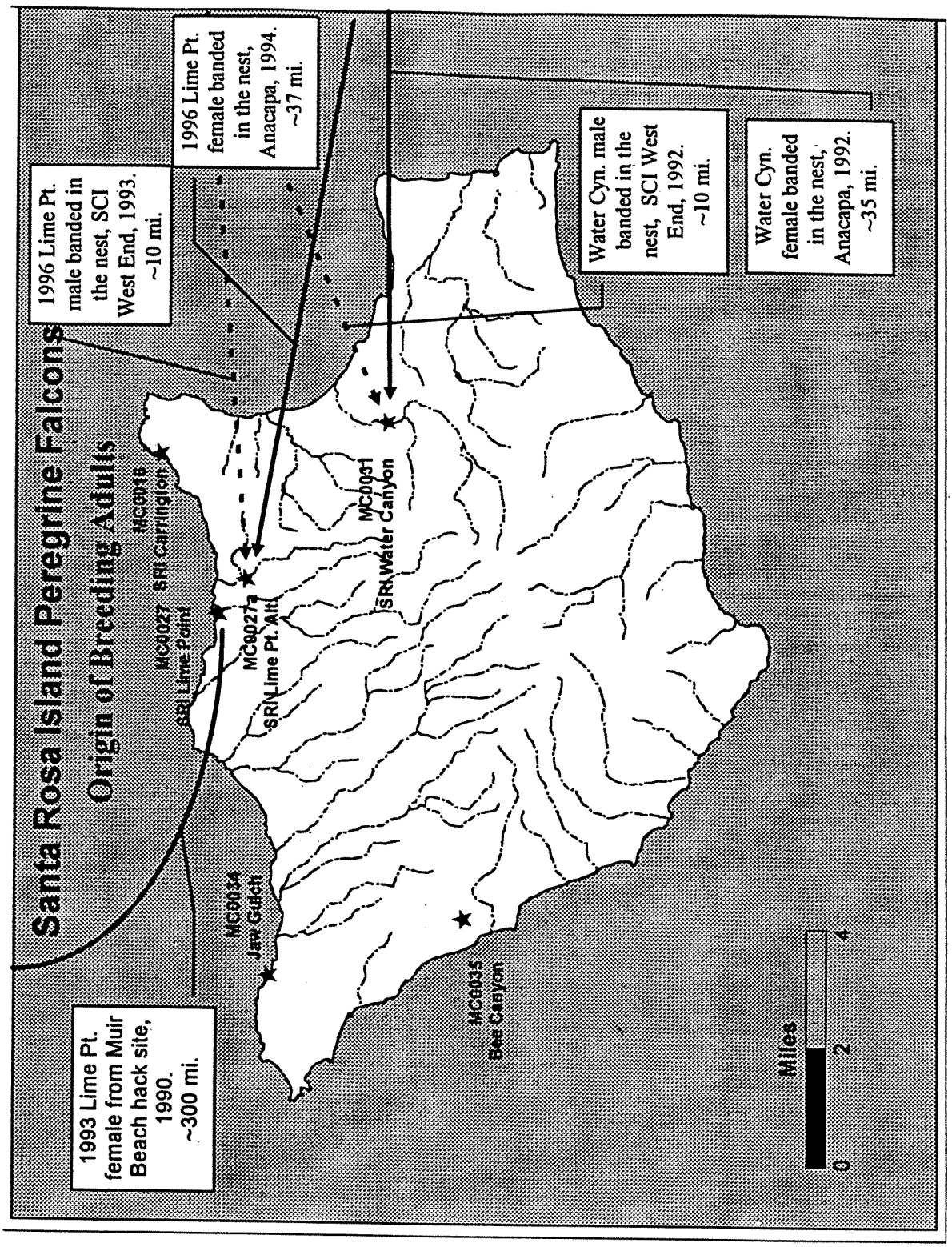


Table 16. History of MC-16, Carrington Point on Santa Rosa Island.

| Year | Status | Outcome | Comments |
|---|---|---|---|
| 1989 | Occupied? | no nesting | a lone falcon was observed here in May |
| 1990 | Occupied | unknown | falcons were seen (?) |
| 1991 | Occupied | unknown | falcons were seen (?) |
| 1992 | Active | eggs not laid | female immature |
| 1993 | Inactive | | |
| 1994 | Active | 1 + young | at least one young produced |
| 1995 | Active | 2 young | |
| 1996 | Active | 1 + young | at least one young produced |
| 1997 | Active | 2 young | |

Table 17. History of MC-34, Jaw Gulch on Santa Rosa Island.

| Year | Status | Outcome | Comments |
|---|---|---|---|
| 1996 | Occupied | | a defensive falcon was observed here |
| 1997 | Active | 0 | |

Table 18. History of MC-35, Bee Canyon on Santa Rosa Island.

| Year | Status | Outcome | Comments |
|---|---|---|---|
| 1996 | Active | | two defensive falcons were observed here |
| 1997 | Active | 1 | |

Figure 18. Dispersal of Santa Catalina Island Hack Site Fledglings.

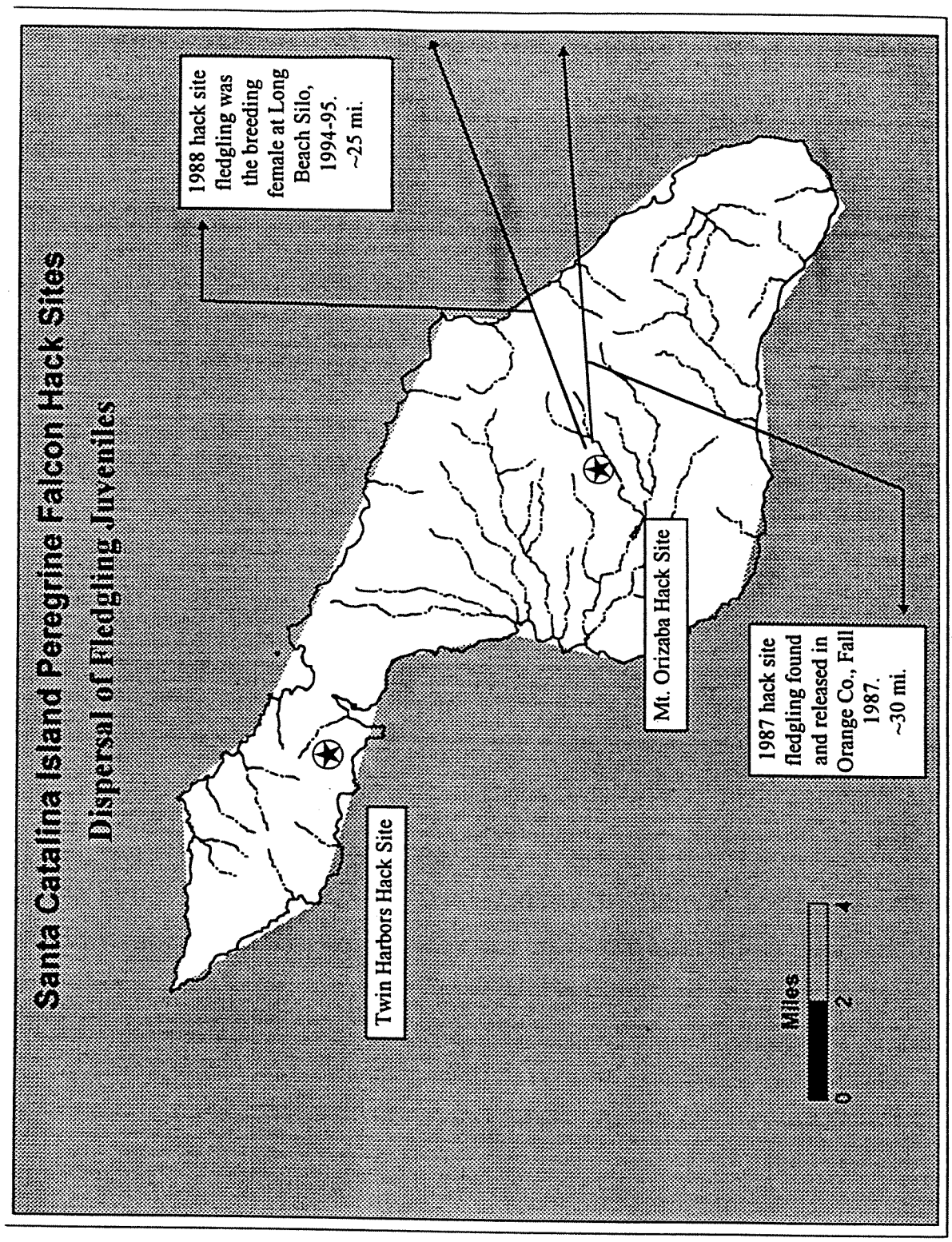
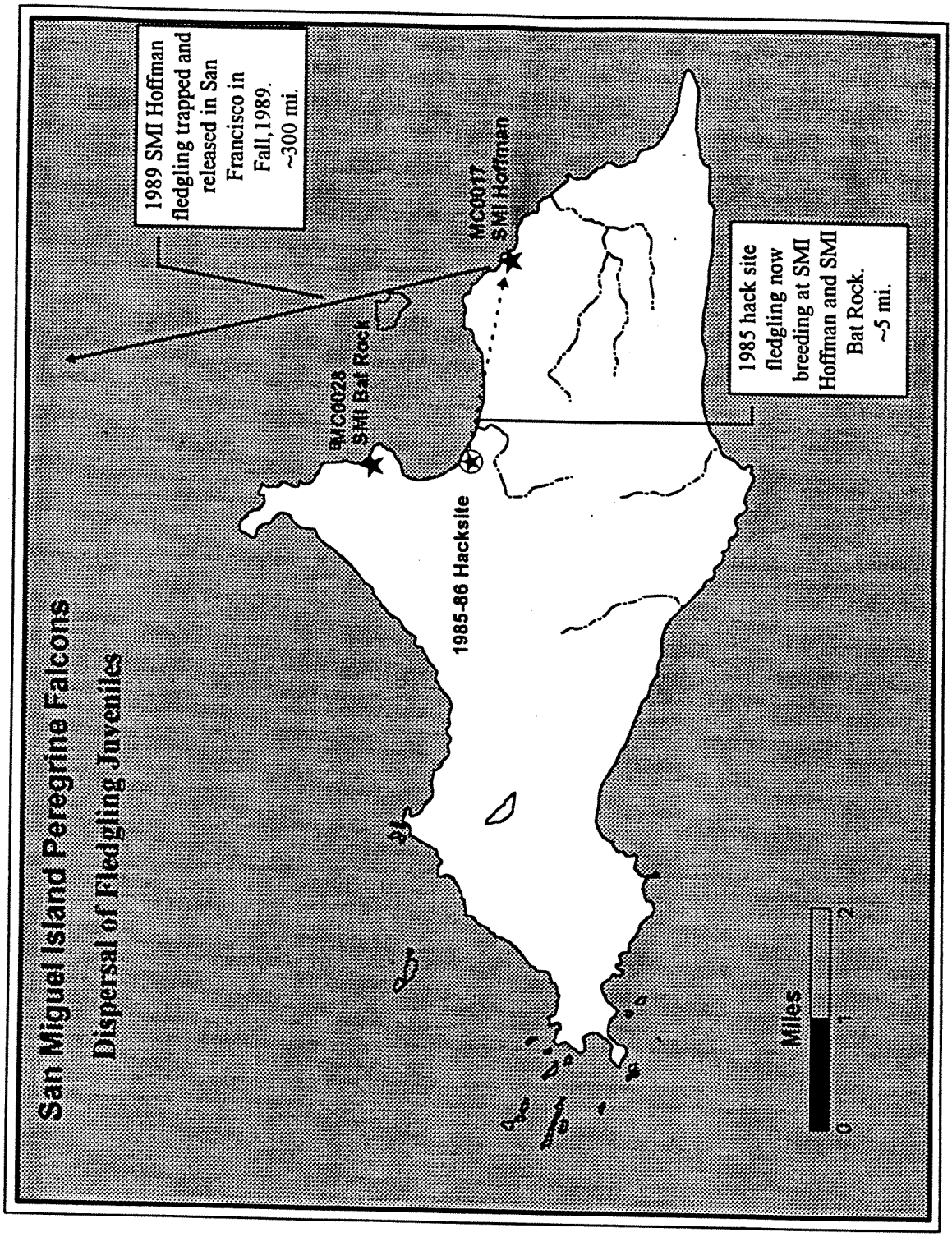


Figure 19. Dispersal of San Miguel Island Hack Site Fledglings.



Tables 6-18 provide a history of activity at Channel Islands territories from the year of first occupancy through 1997. Table 19 provides a summary of information collected for all territories on the Channel Islands from 1983 through 1997. Included are the number of islands occupied, number of total pairs, and the number of young released.

The recovery process on the Channel Islands progressed as follows. Released young occupied historic territories. Peregrines fledged earlier from adjacent territories 10 to150 miles away on the mainland became floaters and were recruited on the Channel Islands. Eventually, the first adult pair occupied a territory on one island. Eggs were laid but broken. Several adult pairs formed and territories became occupied on several islands. Young began to fledge at some territories in some years, but productivity was not normal because of continuing DDT impact and egg failure. In the future the process should include continued recruitment of floaters, emigrations of some fledglings to the mainland, additional pairs occupying territories, additional young fledging from nests, and additional young being fledged from hack sites. Eventually, 25+ territories should be occupied on the Channel Islands with a large number of surplus floaters being present to replace adults that suffer mortality.

The number of territories occupied by pairs and number of young fledged as described in Tables 6-18 are minimums. It is possible that some pairs have not been observed and as a result that young fledged from non-observed pairs are not included in the summary table. Productivity was not determined for some pairs in some years because of financial constraints.

Table 19. Summary of Channel Islands Restoration.

| YEAR | NUMBER OF ISLANDS OCCUPIED | KNOWN NUMBER OF PAIRS | SUSPECTED PAIRS | MINIMUM NUMBER OF WILD YOUNG | NUMBER OF YOUNG RELEASED * |
|---|---|---|---|---|---|
| 1983 | | | | | 3 |
| 1984 | | | | | 3 |
| 1985 | | | | | 7 |
| 1986 | 1 | | 1 | | 6 |
| 1987 | 1 | 1 | | 0 | 4 |
| 1988 | 2 | 1 | 1 | 0 | |
| 1989 | 3 | 3 | 1 | 3 | 4 |
| 1990 | 4 | 3 | 1 | 6 | |
| 1991 | 4 | 4 | 1 | 2 | |
| 1992 | 4 | 8 | 0 | 9 | 2 |
| 1993 | 4 | 8 | | 12 | |
| 1994 | 4 | 8 | | 8 | |
| 1995 | 5 | 9 | | 9 | |
| 1996 | 5 | 11 | | 11 | |
| 1997 | 5** | 13 | | 12 | 2 |

* Includes both hacked and fostered.

** Does not include a female resident on San Clemente Island in 1997.

## Resources Used

Peregrine falcons have been revered by mankind for thousands of years. Because of their unique popularity there is a large, active, passionate, and diverse group of people willing to participate in the study, recovery, and management of this species. Participation by individuals varies widely and includes paid and largely volunteer work, and donations of funds, equipment, and breeding stock under the coordination and supervision of SCPBRG. The lifelong dedication of certain individuals has greatly enhanced the recovery program here and in other areas of the world where similar programs exist. This has increased the possibility for this species to recover and be reintegrated into the modern world.

The overall work force involved in recovery efforts consisted of SCPBRG staff; seasonal employees and volunteers; public associates, both volunteer and nominally reimbursed; students conducting research; and agency biologists fulfilling their mandated monitoring obligations (often on their own time). The amount of time spent on restoration efforts would be staggering if it could be calculated. The nature of the work force and the diversity of their activities makes the number of person-hours expended on the recovery effort impossible to quantify.

The period of work that involved fund-raising, problem-solving, and actual hands-on management activity that enabled recovery to occur (in conjunction with DDT restriction) has reached 20 years in California (1977-1997). Prior to that, work largely concerned legislative actions, initial surveys of historic territories, and investigation of DDT issues in other areas of the peregrine's range (England, East Coast).

Costs for SCPBRG recovery actions including salaries, construction costs, equipment, and other expenses have been extensively reduced by thousands of hours of volunteerism, involvement of students earning credit, and via donations. Large amounts of construction materials and office, lab, and field equipment were provided. As a result, costs described here are considerably lower than they would have been if conducted by normal government or business methods and procedures.

There is an agency cost component that SCPBRG cannot begin to calculate. The California Department of Fish and Game, U. S. Bureau of Land Management, National Park Service, U.S. Fish and Wildlife Service, U. S. Forest Service, and others conducted monitoring activity on lands under their jurisdiction. However, hands-on management activity on their lands and in conjunction with agency personnel was actually conducted by SCPBRG and is reflected in the costs described here.

Salaries paid to full-time SCPBRG employees (17), and "by agreement" employees (318) for office, lab, and fieldwork total $1,950,000 to date (1977-1997). This included captive breeding of birds, developing expertise and techniques, and conducting releases and field studies. Costs associated with facilities construction and equipment, including such items as hack boxes and radio-telemetry devices placed on released falcons, total $380,000. Travel on surveys to monitor occupancy and productivity, collect eggs and prey remains, release young, and related actions totals $405,000. Food for the captive falcon population and released birds prior to their reaching independence totals $210,000. Campus overhead paid to UCSC for University, non-SCPBRG purposes totals $180,000. The cost of the entire peregrine recovery effort conducted by SCPBRG for 20 years beginning in 1977 totals $3,135,000.

## Conclusion

This recovery effort has resulted in a great deal of public education and contribution to scientific knowledge regarding falcons, ecology, pesticides, wildlife management, conservation, and endangered species. The release of more than 700 peregrines to enhance productivity, the increase from only two known remaining pairs to over 120, and the likely delisting of an endangered species resulted from these efforts. Problems remain, stability has not been verified, and the long-term future of the peregrine is unclear. If not for the SCPBRG activities described in this report, the number of active peregrine territories on the Channel Islands would probably be considerably lower at this time. Without these activities, occupancy of the Channel Islands would have been delayed considerably, and the continuing impact of DDT would be much greater, possibly eliminating current reoccupancy and productivity. In 1997, the Channel Islands population is still suffering from reduced productivity. Pairs are not occupying all territories at carrying capacity for this region of peregrine falcon range in California. Recovery actions will continue in the future on the Channel Islands and in California.

Brian James Walton 29 Aug 97

BRIAN JAMES WALTON DATE